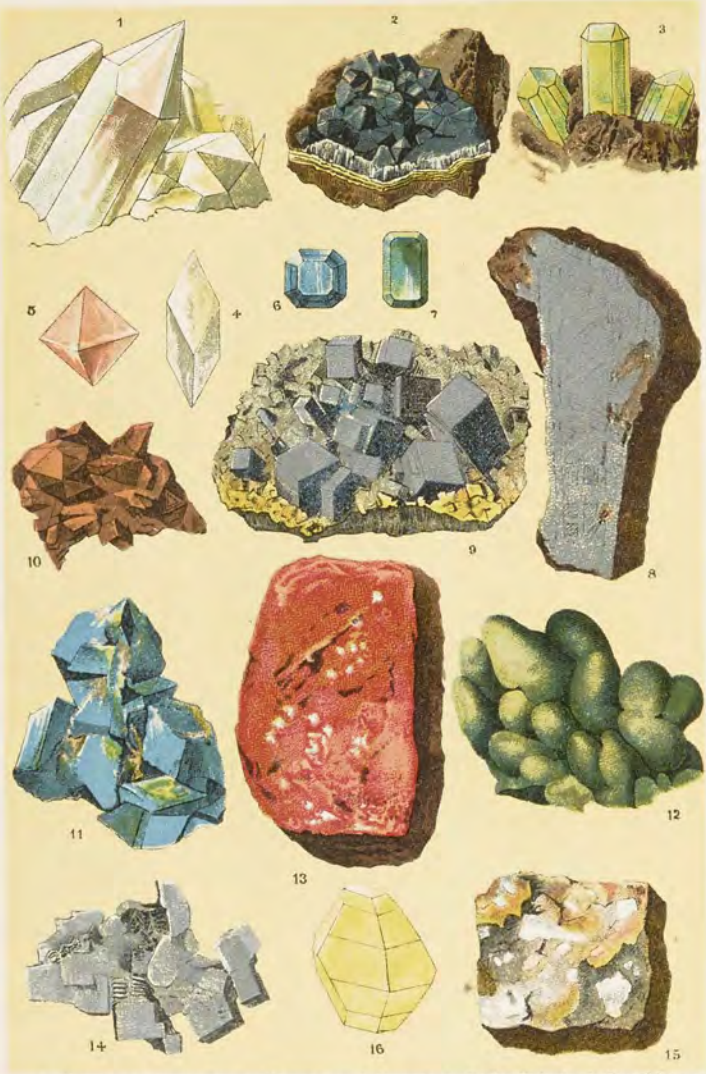
THE BOY MINERAL COLLECTORS

BY

JAY G. KELLEY, M. E.



1, Quartz; 2, Amethyst; 3, Topaz; 4, Calcspar; 5, Ruby Spinel; 6, Sapphire; 7, Emerald; 8, Meteoric Iron: 9, Fluorspar; 10, Cuprite; 11, Azurite; 12, Malachite; 13, Jasper; 14, Galena; 15, Conglomerate; 16, Chrysoberyl.

THE BOY POSTAGE STAMP COLLECTORS

BY

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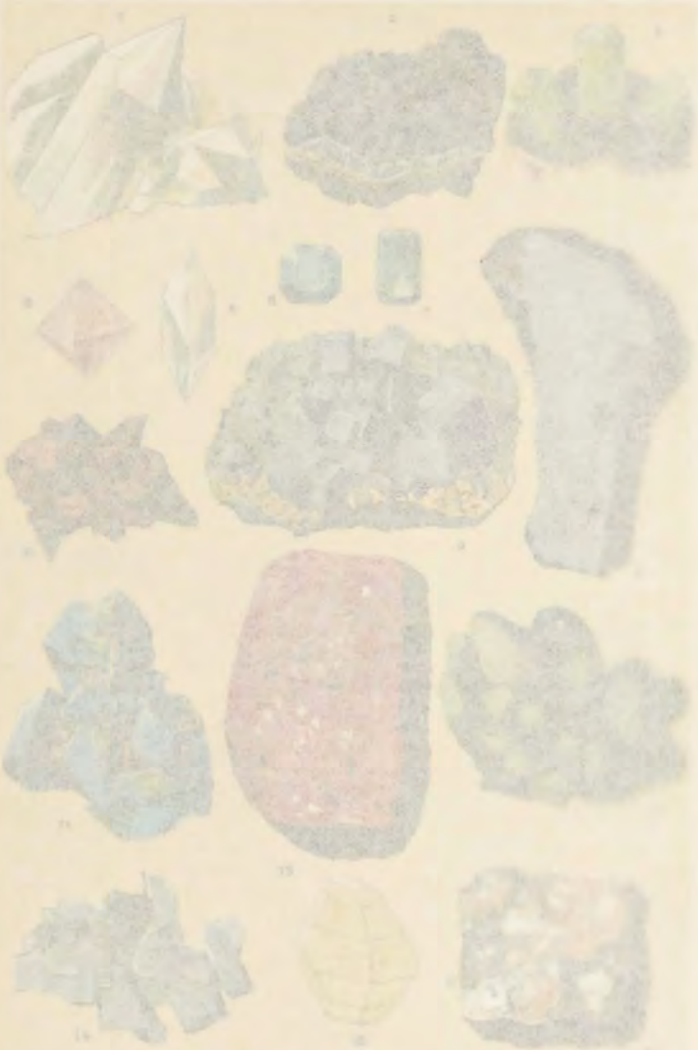

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PHILADELPHIA

J. B. LIPPINCOTT COMPANY

PREFACE.

WHILE it is hoped that the following story will not lack interest in itself, the primary object has been to suggest the endless fund of entertainment and information open to the boy who chooses to pursue the study of mineralogy as it invites him in the rocks, ores, etc., about his own home, supplemented by the collection easily gathered through the occasional investment of pocket money in specimens obtainable from near-by dealers. Technical terms have been avoided, but the mineralogical facts incorporated in the narrative are thoroughly accurate and reliable. If this volume shall prove an incentive to its readers to observe and investigate the mineral world about them, to possess their own cabinets of specimens, and to read the fascinating stories which the common stones of the field as well as the priceless gems have to tell, the earnest desire of the author will be realized.

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THE BOY MINERAL COLLECTORS

CHAPTER I.

THE BOX OF MINERALS.

FRITZ MAYER and Tom White were cousins, who had completed their academical education in Ohio, and, prior to entering college, had been invited to spend three months in the golden West with their uncle, Mr. Benjamin White, of Denver, Colorado, a well-known miner and mineralogist of that section. Fritz was seventeen years of age and Tom sixteen, both of them well grown, intelligent, and cultivated in habits of observation. Fritz had a decided taste for chemistry, and had gained some knowledge of rocks, of which he had already quite a collection, gathered along the creeks and rivers at his home. These consisted of quartz pebbles (which he called milk-stones), a few fossils, among which were several trilobites, and a number of chalcedony arrow-heads and fresh-water pearls.

After a hasty preparation, the boys bade farewell to their friends and started on their journey West. They were met at the station in Denver a few days

later by their uncle Ben and cousin Harry, a boy about their own age, so attentive, bright, and quick-witted that he had surpassed most of his companions in attainments, and had consequently acquired a degree of importance among them. He had a retentive memory and a thirst for information, and had gained considerable acquaintance with chemistry and mineralogy by watching the operations of his father in the laboratory, supplemented by home study. He had also frequently accompanied his father to the mines in the mountains, and had aided him in no small degree while examining as an expert the shafts, tunnels, drifts, winzes, and inclines of the gold and silver mines.

The early days of the visit were spent by the boys in getting an idea of the character of the Rocky Mountain city, so strikingly different from their home in the Ohio lowlands. Lifted a mile in elevation above sea-level, surrounded by the snowy peaks and the deep-blue shoulders of the great western mountain range, its sky normally cloudless, its air dry and invigorating, the visitors felt almost as though walking on air in going about its streets, and could not get over their surprise that in thirty years a rude mining camp had grown into such a populous and bustling city. Harry busied himself in doing the honors of his native place, of which he grew specially proud on finding how warmly it was admired by his Ohio cousins.

But the visitors from the East did not let mere curiosity continue to occupy their minds. They had

come West with a distinct purpose of making a study of mineralogy, so far as could be done in a brief visit, and were not long in displaying their interest in this direction.

A few days after their arrival in Denver, Harry, who had been examining a specimen of iron pyrites with a magnifying-glass, laid it down when done on the window-sill. Here Tom soon found it, and called out somewhat excitedly to his fellow-visitor, "See here, Fritz; just look at this great hunk of yellow gold."

Harry, who had left the room, returned in time to hear this exclamation, and answered with a smile,—

"Very pretty, Tom, but not gold. That is a specimen of iron pyrites which my father brought from the mines a few days ago. Your mistake, though, is a very natural one, for it does look much like gold. And see here, boys; you have said that you would like to take up the study of minerals, and the only way to do that is to begin. Father, I know, will be glad to answer any questions you may ask; and, though I don't want to put on airs, I can safely say that I know something about rocks and minerals. While you have been studying in college, I have been studying in the mines and the laboratory, and can give you a few points. So you had better follow the example of the old philosopher, and ask about everything of which you are ignorant. There is no readier and easier road to learning."

Harry's advice was too closely in accord with their own wishes not to be followed. They found their

uncle quite willing to accept the task laid down for him by his son, and took the first opportunity to put his good nature to the test. Their course of study began one morning, a few days after their arrival at Denver, when they found Mr. White seated in the library, book in hand. Fritz, the most forward of the two boys, opened the conversation.

"Uncle Ben," he said, "you promised to show us your collection of minerals; also to teach us how to test them, and to give us a whole lot of information, of all sorts and kinds, about them. When will you be ready to begin?"

"Why, boys," said their uncle, smilingly, "I would begin at once, were it not that my collection of minerals is boxed up and stored away in the basement. In a few days, however, I shall have them brought up and teach you all I can about them."

"But, uncle, you needn't wait for that," Tom broke in eagerly. "While looking about the city yesterday I saw some small collections of minerals for sale in a store, with twenty-four different minerals in each box. I bought one of these, and have it now in my room. If it is not asking too much of you, and you have time to tell us something about these specimens, I could bring it down in a minute."

"Very well, Tom; bring it down. That will be a good way to make a start."

Tom eagerly left the room, and was back again in little more time than he had promised, bringing with him a neat box of maple wood.

"Here they are!" he exclaimed. "I think they

are beautiful. I know they will be admired by my friends at home."

"You are right, my boy," said his uncle, after a brief examination of the specimens. "They are beautiful, and well worth the price. Now let us see: I suppose the proper way to begin is with No. 1, which I see is labelled 'Malachite and Azurite, Copper Queen Mine, Bisbee, Arizona.' This green part of the mineral is the malachite. It takes its name from the Greek word *maleche*, as its color was thought to resemble the green leaves of the mallow, or *maleche*. Chemically, malachite is an ore of copper. We call it carbonate of copper, it being composed of copper and carbonic acid. It is chiefly valued, however, for ornamental purposes. The palace of the Czar of Russia contains a large number of tables, vases, and other ornaments of this mineral, which are greatly admired for their beauty. It is susceptible of a high polish, and is sometimes used in gems for personal adornment. Large masses have been found in the mine that this specimen was taken from, many of them being sufficiently large, when joined together, and of good enough quality to make table-tops. They were shipped to New York and sold for a good price. But the most costly ornament of this mineral is a vase in the Vatican at Rome, the dimensions of which I have forgotten.

"The azurite, which is the blue portion of the specimen, is also a carbonate of copper; but it differs from the green variety in containing more water. It takes its name from resembling in color the azure

blue of the sky. Azurite is never found in as large masses as malachite; but, like it, is largely used for ornamental purposes and in jewelry. It is frequently palmed off as lapis lazuli."

"Won't you please tell Tom and Fritz," broke in Harry, "the meaning of the word 'ite;' which I think they will find to be the end of a good many more names of minerals than malachite and azurite."

"Well thought of, Harry," said Uncle Ben. "They will find that ending to the names of most of the minerals. It is adapted from the Greek word *lithos* (a stone), and is always used as a final to native minerals. For instance, Professor Hanks, of San Francisco, discovers a new mineral by analysis. He describes it by giving to the world its exact proportions, or constituent parts. He is honored for the discovery by having the mineral named after him, it becoming known as 'Hanksite.' I have made some discoveries myself, but nobody has been kind enough to name any of them 'Whiteite.' Perhaps they do not care to double up the 'ites.'"

"Both these minerals, you tell us, are ores of copper," said Fritz. "How could we learn that ourselves? What would be the quickest way to make a test for copper?"

"If you were familiar with the blow-pipe, you would find a test by that method the best and quickest. Or some of the ore could be pulverized in a mortar and placed in a test-tube with acid. As I have here all the appliances necessary, I can readily show you this operation, and you will certainly find

seeing better than telling. Have your note-books handy, for I would advise you both to keep a record of these tests: simple as they are, they may aid you materially in the future.

"You will perceive that I have placed a small quantity of the pulverized ore from your specimen in this glass tube," continued their uncle, suiting the action to the word. "I now pour upon it enough nitric acid to fill the tube one-third full. You will observe that it begins to effervesce or boil up. This is caused by the carbonic acid gas which has been set free by the action of the nitric acid. By the way, I should like you to bear in mind that all carbonates effervesce when brought into contact with strong acids. The contents of the tube are now, as you may see, of a beautiful emerald green. The carbonic acid has all escaped, and what you perceive is a hydrous, or watery, nitrate of copper. The brown fumes which are escaping from the tube are known as nitrous oxide.

"I shall now pour the solution into three smaller tubes, in about three equal parts, so that I may show you its behavior under different circumstances. The addition of a few drops of ammonia to No. 1 has, as you perceive, changed its contents to a beautiful azure blue. I now place in the second tube a strip of bright zinc. You will soon see that pure copper is deposited. The nitric acid, having a greater affinity for the zinc than it has for the copper, immediately attacks the zinc and sets the copper free in its metallic form. Into the third tube I

place a bright iron wire, and metallic copper is at once precipitated upon it. I hope, my lads, you have got all this safely down in your note-books."

"You can be sure enough I have," cried Tom. "And Fritz has been pencilling away about as fast as he knows how. I had no idea that I could take so much interest in minerals, and I value my little box more than ever. As I suppose that winds up the story of No. 1, may I venture to hand you No. 2?"

"'Forest Rock,'" said Uncle Ben, reading the label on the specimen. "It ought also to be labelled 'Dendrite.' It gets this name from its having upon it figures which resemble trees, shrubs, etc., and are supposed to be formed from the drippings of water containing manganese and iron. The rock itself is porphyry, a mineral that is very abundant all through the Rocky Mountains. Several years ago dendrite was discovered near Placerville, California, in large slabs, which bore markings much like a dense forest and watercourses, while a little stretch of the imagination seemed also to find pictures of houses and animals. Those slabs were exhibited all over the United States, and were certainly remarkable as products of nature, they appearing at a short distance like sketches in crayon. They were advertised as 'Photographic Rock.' That, I think, is all I need say about this specimen. Hand me No. 3, Harry."

"Here it is," said Harry; "and a very handsome specimen, I should say."

"Quite handsome, indeed," said Uncle Ben. "I

see it is marked 'Turquoise in the matrix.' Turquoise, as perhaps you know, is classed among the high-priced gems when it possesses a sky-blue color and is without flaws or specks. It is highly prized in Persia; and it is said the Shah of Persia has in his possession the largest and most costly collection of turquoise in the world. The chemical composition of this mineral is hydrous phosphate of alumina, with a small percentage of copper oxide. The lustre of turquoise is somewhat waxy, while the imitations have a glassy appearance. The genuine stone when placed on the forehead feels cold to the touch, as you may find on trial with this specimen."

As Fritz made the experiment, Harry whispered to Tom, who at once called out, "Uncle Ben, Harry says that this is not peculiar to turquoise, but that all genuine precious stones feel cold to the touch."

"Very nearly so, that is a fact," said Uncle Ben; "but not quite, for the opal is an exception. But no such test is needed for opal, for no person has succeeded in successfully imitating it. Thus far it has been found impossible to reproduce the beautiful opalescence which nature gives to that gem. To return to turquoise, I may state that it has been found in several localities in Colorado, and that the mines at Los Cerillos, New Mexico, have been worked for nearly three hundred years. It has also been recently discovered near Silver City, New Mexico."

"But, Uncle Ben," asked Fritz, "does not the

finding it in such large quantities destroy its rarity and cheapen it as a gem?"

"Oh, it is not the precious turquoise that is found in large quantities. In fact, it is a rare event to find a specimen of the exact sky-blue tint that gives it value as a precious stone. I examined one a few days since in a jewelry store, a trifle larger than the first joint of your little finger, and it was valued at one hundred and seventy-five dollars. Turquoise holds rank as the lucky stone, and there is a proverb in Russia that a turquoise given by a loving hand carries with it happiness and good fortune.

"Turquoises were held in high esteem by the Aztec Indians, and it was the custom, on the burial of a chief of that nation, to place one of them in his mouth. Many of their idols were decorated with turquoise in mosaic, the ground-work being in the most primitive style, consisting of a layer of pitch on which were laid the fragments of the mineral. Montezuma's present to King Charles V., of Spain, contained a large number of turquoise gems, and Father Claverigo, who was with Cortez, says, 'The present to the Catholic King consisted of various works of gold, ten bales of most curious rolls of feathers, and fair gems, so highly valued by the Mexicans that, as Tehuitlile himself, the Ambassador of Montezuma to Cortez, affirmed, *each gem was worth a load of gold.*' The value of turquoise has been steadily advancing for several years, on account of the small yield of the mines at Nishapur, Khorassan, Persia, hitherto the source of the finest speci-

mens. I may add, that the name of the mineral is stated to be due to its having first been brought to Europe from Turkey."

"Well, No. 3 has been interesting enough, I am sure," said Fritz; "more so, I fancy, than No. 4, which looks like a chunk of pitch."

"Looks do not always represent facts in mineralogy," answered Uncle Ben, as he took the specimen. "This is marked 'Obsidian, or Volcanic glass,' the latter name being due to its glassy nature and its being the product of a volcano. It differs in composition from the glass of commerce, it being felsite, a mineral composed of silica, alumina, and potash, which has been fused by the heat of the crater. The pumice stone of commerce, with which you are all familiar, is the same material, though under different conditions, it having cooled while in a frothy state. It is known to scientists as 'Feldspathic scoria.' Obsidian was in great demand among the Indians, who fashioned it into arrow-heads, spear-heads, knives, war-clubs, etc. Its value for such purposes lay in the sharpness of its edges when broken. It is sometimes employed as a gem, in imitation of smoky quartz. There is a green variety which, when cut and polished, resembles the peridot and green tourmaline, but is too soft to be classed among gem stones."

"Is it found as a product of all extinct volcanoes?" asked Tom.

"Oh, no," was the reply, "only where the outpour is composed of feldspathic material, which is by no

means always the case. How about No. 5? What is it like?"

"It looks like another piece of carbonate of copper," answered Fritz, "but is labelled 'Amazon Stone.' Here it is, uncle."

"Thank you, Fritz. Amazon stone, or Amazonite (both names are in use), does certainly resemble carbonate of copper, but it has no copper in its composition. It is, in fact, a green variety of the mineral known as feldspar. Formerly it was only found in Siberia, but it is now obtained abundantly from the base of Pike's Peak, Colorado, where very handsome specimens have been found. Its green color is due to an organic compound of iron. It is rare to find a specimen that is good enough to cut into gems."

"Well, there is something in mineralogy," cried Tom, excitedly. "You can't imagine how interested I am in your descriptions, Uncle Ben. Books on this subject have always seemed to me to be made up of Latin, Greek, and hieroglyphics; but I see that minerals are not quite the dry and cold affairs I fancied them. I am sure it will become a favorite study with me, if I can help out the books with the live specimens, if I may call them so."

"I am glad you like it," said Uncle Ben, in a pleased tone. "You are only on the threshold of the study yet. What comes next? Ah, I see. No. 6. 'Silver Lead Ore from the Little Chief Mine, Leadville, Colorado.' The scientific name of this

substance is cerusite. In chemical language it is a carbonate of lead. It is a very common ore, and is found in nearly all lead mines, particularly when the vein is in contact with limestone. It is also found as a beautiful creamy or amber-colored crystal, which is sometimes translucent."

"But you said 'silver lead ore,'" remarked Fritz. "Does that mean that it contains silver as well as lead?"

"That is the idea, exactly. Under the magnifying-glass you will find filmy scales of what is known as horn silver. The naked eye does not detect it."

"Is there enough silver to make it worth working for that metal?" asked Tom, much interested. "If so, how is the silver got out?"

"It is worked both for silver and lead," said Uncle Ben. "The ore is shipped to the smelters, where it is melted with charcoal and with some such fluxes as lime and iron. As the process goes on, the furnace is from time to time tapped a short distance above the bottom, and the fluid slag drawn off. The molten metal, on account of its gravity, sinks through the slag to the bottom and flows through an inverted siphon, leading to the outside of the furnace, into a cup, from which it is dipped and poured into moulds. The bars or ingots now contain all, or nearly all, the silver and lead that were in the ore, and are shipped to a refinery, where the silver is extracted. In a small way the silver may be separated from the lead with a cupel."

"A cupel," exclaimed Fritz, pouncing on this as a

word new to him. "And, pray, what is a cupel, uncle, and how does it work?"

"That's right, my boy; ask questions if you want to get facts," said Uncle Ben. "A cupel is a small cup made of bone-ash, having straight sides and a flat bottom. In their use these cups are placed in a muffle and made red hot, after which a lump of lead, weighing, say one ounce, and containing, say forty grains of silver, is placed in each. The door of the muffle is then closed for a few moments to exclude the air, or until the ore has become melted in the cupels. The muffle-door is then opened to admit the air, which oxidizes the lead. The cupels will now absorb the lead oxide but not the silver, while the metallic lead remaining is vaporized and driven off in fumes. After a time the lead entirely disappears, and the forty grains of silver are left in each cupel, in globular form. Bone-ash has the property of absorbing all of the metals, except gold, silver, and platinum. It was the discovery of this cerusite silver ore in immense quantities at Leadville, Colorado, in 1887, that caused the excitement at that time, and gave the town a population of more than fifty thousand in a few months."

"You spoke of a muffle, Uncle Ben," said Tom. "I confess my ignorance, and would be glad to have you tell us what a muffle is."

"It is an arched vessel in the shape of an oven, and made of fire-clay, which will resist a very strong heat. The muffle is flat on the bottom and rounded on top, being usually from nine to sixteen inches in

length and five to eight inches wide. This is placed in the centre of the assay furnace with the fuel surrounding it, and serves to protect the cupels from contact with the smoke or ashes."

"And what is bone-ash?" asked Fritz.

"It is calcined bone; the earthy part that is left after the animal matter and carbon have been consumed by heat. It consists mainly of phosphate of lime, but contains a little carbonate of lime."

"Well, we are getting along swimmingly," said Fritz, in a merry tone. "My note-book is a sight to behold. Here comes No. 7, which is labelled 'Gold quartz.' We are not wearing out your patience with our curiosity, Uncle Ben?"

"Not at all," said their indulgent uncle. "I am as much interested in the subject as yourself, and enjoy talking about it. This appears to be a very rich specimen of gold quartz. It seems to be covered with tiny specks of gold."

"I should not call this one tiny," said Fritz, pointing to a yellow spot of some size.

"This is not gold, my boy. If it was, gold would soon be a drug in the market. It is what is known as pyrites; being a sulphide of iron, which is found in nearly all gold mines. The pyrites, in some districts, in fact, carry all the gold. It is easy to distinguish one from the other. Take my knife, and try to cut the pyrites. You perceive that the blade has no effect upon it; on the contrary, it is so hard that it turns the edge of the knife-blade. Now cut this

speck of gold; you observe that it is easily marked and is malleable."

"How do the miners get the gold out of the rock?" asked Fritz.

"They pulverize the stone in an iron mortar until fine enough to pass through a sixty-mesh sieve,—that is, one with sixty meshes to the inch. It is then put into a clean iron pan with flaring sides, and washed in a stream or in a tub of water. The pulp in the pan is first well soaked, and then tipped forward enough to allow the earth to come to the point or edge of the pan, so that the water may run in and out of the pan, which is constantly shaken with a sort of figure 8 movement. The particles of gold will sink to the bottom, and the light sand will be gradually washed out of the pan, while the gold remains. This is a natural result, since the gold weighs nineteen times, and the sand only two-and-a half times as much as water."

"And does Harry understand how to wash gold in a pan?" asked Fritz.

"Very well, indeed," said Uncle Ben. "Harry has panned gold ever since he was a little boy, and is now looked upon as one of the most expert panners in the West. If you would like to see some practical mining, Harry can take you tomorrow to a place on Cherry Creek where gold exists, and give you an ocular demonstration of the operation. You can at the same time try your own hands at panning. But there goes the bell announcing that dinner is ready. We shall have to

postpone the remainder of our talk till some future time."

"I for one am sorry to hear that bell," said Tom; "and I am not often sorry in that way. I'm sure Fritz and I thank you warmly for the trouble you have taken to instruct us."

"We shall need many more sessions yet before our task is ended," answered their uncle, kindly. "But just now dinner has the place of honor."

CHAPTER II.

HARRY AS A TUTOR.

NEXT morning, Barney the coachman had the carriage and horses in waiting at the door, ready for an early start. Harry and his two cousins soon appeared, carrying pick, pan, and shovel. Entering the carriage, they were driven to a spot on Cherry Creek where gold was known to exist in small quantities, and where they spent most of the day panning for gold.

Aided by Harry's instructions, the boys were soon taught how to "pan out," and succeeded in getting a few scales of gold in each panful of earth. On their return, the gold was weighed and found to be worth the enormous sum of thirty-two cents.

In addition to their enjoyment of the new experience, and the intensity of expectation with which Tom and Fritz watched for the tiny yellow scales in their pan, they found the day a delightful one,—the weather being perfect, the sky a glorious azure, and the surrounding hills and far-off peaks an unceasing source of delight, their previous life having been spent in a flat country. Drinking in deep breaths of the dry, bracing atmosphere, and wandering along the bank of the stream, they found the outing a continual charm, and the sun was near its setting when they

set out for home, proud of their day's achievements and with the health of the mountains in their veins.

Harry explained to his cousins that those were not the kind of "diggins" that miners looked for, and promised in the near future to show them a genuine gold-placer mine, where he could get from one to three dollars' worth of gold in each panful of gravel.

They had proposed to continue their examination of the minerals in Tom's box on their return, but, as the hour was late and they were rather tired, this was put off till next day.

"Harry, my son," said Uncle Ben, as they were seated around the breakfast table the following morning, "I shall be absent to-day at the smelting works. Two car-loads of ore came in last night, and I want personally to superintend the sampling of the ore. I shall have to leave your cousins to your tender mercies for the day. You can begin where I left off, and describe the minerals in Tom's box. You need have no fear, boys, of having a poor teacher, for Harry is as well informed on such matters as I am. He has been brought up on minerals, and very likely could give me information in some directions."

Harry laughed at this praise, and looked with twinkling eyes at the boys.

"You see what an able professor you are likely to have," he said; "according to father, what I don't know about rocks and stones isn't worth knowing. But maybe you had better not swallow quite all that.

I am afraid, if I attempted to give my father points on mineralogy, I'd soon run up against a snag. It would be like pouring water into a full vessel. But, anyhow, I will do the best I can."

"I have no fear of your stumbling," said Mr. White, smilingly, as he rose and left the breakfast table.

"Come now, young gentlemen," said Harry; "prepare to digest an early morning lesson. If you don't mind, though, suppose we take a turn outside first, and get some fresh air before we settle down to hard facts."

"Agreed," cried the boys together, and a quick run was made for their hats and for the street door.

An hour afterwards found them in the library, Tom's box on the table between them, and Harry in the chair of honor, with an assumed look of wisdom on his fresh young face.

"You've something of a jaw-breaker to begin with," said Tom, reading the label on specimen No. 8. "'Rhodocroisite;' there is a mouthful of a name."

"Long enough, that's a fact," said Harry, "and not a bad specimen. The rhodocroisite means the rose-red mineral, and this is a very handsome crystal of it, pellucid as light wine. I want to show you something about this, an optical experiment which I hope may succeed. I draw a straight line on this piece of paper and place the crystal over it. Look through it, Fritz, and tell me how many lines you see."

"How can I see more than there is?" asked Fritz. "I am not given to seeing double. There is only one line to be seen."

"Look again," said Harry, turning the crystal on another of its faces.

"There is only—no, I vow if there isn't two lines. Look, Tom, and tell me if my eyes have gone wrong."

"Not a bit of it. There are two lines, sure as shooting," exclaimed Tom.

"I was not sure if it would work," said Harry. "All crystals don't. That is what is called double refraction. That is, the light passing through the crystal is divided and reaches the eye in two rays, each of which shows you its special line. The mineral is a rare one, and you might hunt a long time to find a crystal as clear and transparent as this. To a scientific collector it would be worth more than five times the money that you paid for the whole boxful."

"What is rhodocroisite?" asked Tom. "I want to get down its chemistry in my note-book."

"It is carbonate of manganese, and is made up of fifty-eight per cent. protoxide of manganese, four per cent. protoxide of iron, thirty-eight per cent. carbonic acid."

"That's down," said Fritz, "and your long-named specimen is back in the box. Here's something with a shorter and more familiar name, 'Moss Agate.' I've heard of it often enough, but know no more about it than the man in the moon."

"Agate is a common enough mineral," said Harry, "but fine moss agates are not so plentiful. They are formed in cavities of basaltic lava, which have resulted from the imprisonment of air- or gas-bubbles while the rock was in a molten state. After the rock cooled, the cavity became filled with a deposit of silica that made its way in from without. Traces of iron or manganese got into the cavity at the same time, and it is these that have given to this specimen its dendritic or moss-like markings, hence its name moss agate. It is also called Mocha stone, from Mocha, Arabia, where it is found in abundance. The name agate comes from Achates, a river in Sicily, which was its source of supply in ancient times. On your maps you will find the river now called the Drille."

"You seem up on agates, anyhow," said Tom. "And while on that subject, I think we had better make a jump in the box. No. 21 is labelled 'Ribbon Agate.' Don't you think we should take that next?"

"Why, yes; it comes in best at this point, for the two minerals are merely varieties of the same thing. Ribbon agates are formed in cavities, the same as moss agates. But while the latter were produced by a concentration of silica from all sides gradually filling the cavity to the centre, the ribbon agate was formed by a deposit of layers from the bottom upwards, in obedience to gravitation. There are other varieties of agate, each getting its name from the character of the lines, which suggest a resemblance to some object. Thus there is fortification agate,

rainbow agate, clouded agate, circular agate, eye agate, and many others. Have you got all that down?"

"Safe and sound."

"Then what comes next in the box?"

"No. 10," said Fritz, taking out the specimen. "It is another of the 'ites,' labelled 'Calcite.' What is it chemically?"

"Crystallized carbonate of lime," said Harry. "It is a widely diffused mineral and includes all the white and most of the colored marbles. Chalk is of the same composition, but is earthy, and not crystalline. I need not tell you what lime is."

"You needn't?" cried Tom; "I think you need. Lime is lime, that is all I know about it; except that the hydrate of lime is whitewash."

This sally raised a laugh, which was broken by Fritz asking,—

"What is lime, then?"

"Oxide of calcium," answered Harry, briefly.

"But that only clears up one mystery by starting another. I know that oxide of calcium must be a combination of oxygen gas and calcium. But what is calcium?"

"It is one of the metals," said Harry; "light yellow in color and about as hard as gold. It is very malleable, and burns in chlorine with a most brilliant flame. It is not used much in its metallic state, but as lime there are few minerals more useful."

"Oh, yes, I know what lime is, and mortar and whitewash," said Fritz; "and even marble, chalk,

and limestone. Let us go on to No. 11. What is it, Tom?"

"Don't ask me," said Tom, "except for the name. We must look to our Solomon for the rest. It is labelled 'Satin-spar.'"

"Which your Solomon says is still lime, but in another shape this time," remarked Harry. "We have in this specimen the sulphate instead of the carbonate,—that is, it is sulphur and lime combined. When polished, satin-spar has a silky or pearly lustre, and on this account the Italians use it to make imitation pearls."

"Artificial pearls!" exclaimed Fritz. "Now there is something I want to know about. If there is money enough in them I might go into the business. How do they make them, Harry?"

"I am afraid the Italians are ahead of you in the business," laughed Harry. "They have been making them for ages, and they are still known as 'Roman Pearls.' They are cut from satin-spar obtained near Pisa, in a shape to resemble pearls. The pieces are first rubbed with shark-skin to remove their inequalities, and then dipped into beeswax to give them a yellowish or creamy hue. Afterwards they are dipped into a silvery liquid, which is procured from the air-bladder of the 'Argentini,' a little fish that is common enough in the Mediterranean Sea. The Roman pearls have the advantage of being less fragile than the French imitations, and can be dashed upon the ground without receiving the least injury, which would not be a very safe experiment with the French."

"How do they differ from the French imitations?" asked Tom.

"The French use small hollow globes of glass, which are filled with wax and coated with a silvery substance obtained from the scales of a fish called the 'Bleak.' These imitations are very good, but, as you may imagine, are very fragile."

"You are a regular living encyclopædia, Harry," said Fritz. "I am afraid we will not be able to stay long enough to learn half you know about minerals; and I think I shall have to speak for you for a professorship in the college where I am to finish my education."

"Thanks for the compliment, Fritz. I do not know but what I might hold my own with some of your professors. But let us be getting on. What is No. 12?"

"It is marked 'Smoky Topaz,'" said Tom.

"That is the name jewellers give it," said Harry; "at least, when they get handsome specimens of it like this. But the fact is that it is not topaz at all. It is really quartz that has been colored by some other mineral. Generally this mineral is deposited on the surface, but in some cases it penetrates the crystal, which is then known as 'Venus Hair Stone.' There are several other varieties which are distinguished by their colors. The yellow variety is known as 'citrine' or 'false topaz,' the brown crystal, like this one, as 'cairngorm' or 'smoky quartz,' and the black-colored as 'morion.'"

Their conversation was interrupted at this point by

the entrance of Mr. White, who looked with a smile at the intent attitude of the three boys.

"Well, how do you like your cousin Harry as a teacher of mineralogy?" he asked.

"Why, he certainly knows more about it than I do," said Fritz; "though that is not saying much. You can see the result, Uncle Ben, by my note-book. It is filling up so fast that I may have to get another one for to-morrow."

"And I, too," said Tom.

"I hope to have time to take you in hand to-morrow," said their uncle. "You know that I went to the smelters to-day to sample my car-loads of ore. To-morrow I propose to tell you how that is done. What is more, I have a surprise in store for you. Your aunt Lida and your cousins Eva and Inez will return to-morrow evening from the City of Mexico. I hope they will make matters livelier for you."

"I for one am glad to learn that," said Fritz. "Not that time has hung heavy on our hands. I don't think I was ever kept so busy in my life before; but I did want to see them before I went home."

"I hope they enjoyed themselves in Mexico," said Tom.

"They write that they have had a delightful time, and have no end of new matter to talk about. And I fancy that you will find a fresh teacher in Inez. She knows as much about precious stones as Harry does about common ones, and likes to air her knowledge as well."

"Now, that is not fair," protested Harry, with a

flushed face. "It was you, father, who first praised my knowledge and set me to airing it."

"Come, Harry, when you are older you will take a joke easier," answered his father, pleasantly. "I do not fancy that Tom and Fritz have quite exhausted you yet, though they may have asked some puzzling questions."

"None that he has not been able to answer," said Tom.

"Not he; he came up straight to the mark every time," added Fritz.

"Well, you had better not tire yourself by absorbing too much knowledge at one sitting," said their uncle. "It does not hold on well when taken in too large doses. I should advise you to drop your lesson for to-day and alternate instruction with amusement."

Teacher and students alike were not slow in taking this advice, leaving their uncle alone in the library, which Harry shrewdly fancied was what he wanted just then.

CHAPTER III.

THE BOTTOM OF THE BOX.

NEXT morning Uncle Ben sauntered into the library, where he found the boys, Tom and Fritz, waiting for him, Harry having gone to the railroad station to meet his mother and sisters.

"I promised you a lesson in the sampling of ores," he said, as he seated himself. "The superintendent of the Nibelungen mine (of which I am the principal owner) notified me by letter that he had shipped to the reduction works two cars of ore, which were to arrive in Denver a few days ago, and the officers of the reduction works informed me that they would be ready to sample the ore yesterday. That was what took me away, and I wish now to tell you the way in which it is done. To begin with, the ore is shovelled from the cars on to a raised platform, from which it is shovelled into a rock-breaker. It emerges from the latter in a crushed state, and is then well mixed on the platform floor. It is now divided into quarters, one of which is again passed through the rock-breaker for further crushing. Once more it is divided into quarters, one of which is passed between steel rolls, which crush it to about the size of ordinary sand and drop it on to an iron floor, where it is again mixed by the workmen and divided

as before. One-quarter is now taken to the assayer, who causes it to be pulverized fine enough to pass through a sixty-mesh sieve. From this fine material, which is spread out on a table, the samples are taken. Of these, two are handed to the owner, one of which he has assayed by his own assayer, while the smelting company tests the other by its assayer. To illustrate how thoroughly these samples are mixed, I wish to say that in the past three years there has scarcely been any perceptible difference between the results obtained by my assayer and the one employed by the smelters. I have here the samples obtained to-day. These will be assayed to-morrow, after which I will give you the results."

His intent listeners, who had diligently worked away with their pencils during this explanation, now carefully examined the samples which their uncle laid on the table before them, he answering the eager questions which sprang to their lips. Doubtless they were not all of the most sensible character, but Uncle Ben answered them all gravely, giving ignorance its due allowance, and being aware that the boyish mind does not move in quite the same lines as the mature one. After they had finished this examination and cross-questioning, their uncle remarked,—

"I have some spare time now, and, as Harry is absent, I may as well go on with the investigation of Tom's box of minerals. Where did Harry leave off? At No. 12, eh? Well, we will start in with No. 13, which I see is marked 'Peacock Ore.' That is the common name for a valuable ore of copper

which is sometimes known as purple copper, and also as horse-flesh ore. Chemically, it is a sulphide of copper and iron. It crystallizes in the cubic form, and is of a light-yellow color, but tarnishes quickly, assuming on doing so all the colors of the peacock's feathers. You will find a description of it in mineralogy, under the headings 'Bornite' or 'Erubiscite.' What comes next?"

"It is labelled 'Copper Pyrites,'" said Tom. "It looks like gold."

"Yes," said Uncle Ben, "and has been taken for gold more than once by parties not familiar with minerals; sometimes to their sorrow. Chalcopyrite, or copper pyrites, is an abundant ore of copper, and is found in nearly all the mining States and Territories. Its color is a brassy yellow instead of golden, as just now suggested by Tom; but, as I have said, it is frequently mistaken for gold, and, for that matter, it often carries gold in appreciable quantities. So much for that; now what is No. 15, Tom?"

"It is marked 'Petrified Wood,' the label saying that it is found near Denver."

"I think that is very likely, as it is abundant in this vicinity. I recollect finding, a few years ago, a large petrified trunk of a tree, with the branches still adhering to it, a few miles above the mouth of Cherry Creek. In fact, it is a common incident to find along the sources of Cherry, Kiowa, and Bijou Creeks petrified logs from sixty to seventy feet in length."

"Were these once trees or do they only look like trees?" asked Tom. "I have learned this much,

that minerals are not always to be trusted or judged by their looks."

"They may be in this case, my boy. These were once undoubtedly tree-trunks, but, through infiltration or deposition of silica, they have been changed to stone."

"Infiltration of silica?" repeated Fritz, in a questioning tone.

"Yes. Silica, which you may know to be the same as the hard material of quartz rock, can be dissolved in water under certain conditions. The wood of these trees is supposed to have been penetrated by water holding silica in solution. They became water-soaked, and as the water slowly dried out or evaporated it left its silica behind it in the tree. The woody matter seems to have decayed and disappeared, while the glass-like silica took its place, and that so completely that every cell and fibre of the wood are reproduced in stone."

"Well, that certainly is curious and interesting," exclaimed Tom. "I suppose it took place when the wood was covered up or under the surface, the water soaking through the ground."

"That was perhaps the case," answered Uncle Ben; "yet there is a petrified forest in Arizona where trees with their branches were still standing a few years ago. There the water must have entered in some different way. Fine varieties of this material are employed in cheap jewelry. The last time that I was in New York I saw a column of petrified wood that had been polished. It was about three feet in

height and about ten inches in diameter, and was valued at two thousand dollars. According to statistics, more than ten thousand dollars' worth of petrified wood is used annually in the United States. Ah! Pray excuse me a moment till I answer that call on the telephone."

The telephone bell had just rung, and Uncle Ben rose and walked to the instrument, where the following one-sided conversation took place :

"Hello! Who is it? ah, Mr. Harris,—yes, yes. How much did you say? lead twenty-two.—All right, go ahead.—Silver two seventy-three (two hundred and seventy-three ounces); and gold, how much?—How much did you say?—six and four-tenths ounces?—all right; thanks."

He returned to the table, remarking,—

"Boys, here is the result from my two car-loads of ore. They held exactly twenty-two tons, and each ton has been found to contain two hundred and seventy-three ounces, of silver. Silver is quoted to-day at ninety cents per ounce; so that the value in silver is five thousand four hundred and five dollars and forty cents. The ore also contained in each ton six and four-tenths ounces of gold, which is valued at twenty dollars per ounce. Each ton, therefore, contains one hundred and twenty-eight dollars in gold, and in twenty-two tons, two thousand eight hundred and sixteen dollars. This amount, added to the value of the silver, gives us a total from the two car-loads of eight thousand two hundred and twenty-one dollars and forty cents, without calculating the value of the lead."

"Well, I declare!" exclaimed Fritz. "Thank you for the information, uncle. I am certainly going to be a miner, if that is the way you pick up money."

"Oh, yes, my boy; but I should advise you first not to think that this is all profit. It required the labor of ten men a whole month to get that ore to the surface. Then came the hauling by wagon to the railroad, then the freight charges on the railroad, and finally the charges for sampling and reduction, so that not more than half that amount is clear profit."

"Then you have an income of only about four thousand dollars per month," said Tom, in a tone of quiet amusement.

"Only?" cried Fritz. "I wish I had an income one-tenth as large. I should be the happiest boy in the land."

"But, my dear young speculators," said their uncle, "this business of mining is not always as rosy as it looks to you now. This is the end, not the beginning, of a career. I have been in the Rocky Mountains for thirty-five years, and have led a hand-to-mouth sort of an existence all that time, with the exception of the last three years. Now I feel that I have pulled out of the old rut, and, to use a slang term, 'I am living on Easy Street.' But for many years, your aunt Lida and I lived on bacon and slapjacks. It seems to me now, however, that we were just as happy and contented then as we are at present; perhaps more so. After a mine is dis-

covered it takes hard work and lots of money to make it pay, and considerable skill and experience to keep it on a paying basis. But I see that it is about train time, and think I had better join Harry at the train, to meet my wife and daughters; we shall have to put off further description of the rocks till some later opportunity."

Aunt Lida and her two handsome daughters arrived home on time, and were delighted to learn that Tom and Fritz were still in Denver. The boys and girls were not long in becoming well acquainted, and in the evening Eva and Inez gave their boy cousins a synopsis of the many interesting things they had seen on their trip, and promised at some future time to describe to them in detail all their experience with the Mexicans.

Harry had told his sisters how desirous the boys were to learn something about the science of mineralogy, and Inez promised them that, to vary the monotony of that science, she would occasionally tell them something about precious stones, which we may here say was her pet hobby.

All next day Inez and Eva were too busy in receiving welcomes from their many girl friends to pay any attention to Fritz and Tom, so that they had the library to themselves. Uncle Ben volunteered to continue his description of the minerals in Tom's box, saying to the boys, as a prelude, that it was a real pleasure to him to talk to them about rocks, since it brightened up his memory on minerals that he had nearly forgotten.

"I'll venture to say you never had two more attentive and appreciative students," remarked Tom. "We have each almost filled two books with notes. Now, if you are ready to be troubled, here is the next specimen in order. It is marked 'Zircons in matrix.'"

"The zircon," began Uncle Ben, "known also as the jargon, is a silicate of zirconium. It is largely employed as a gem-stone, the most valuable being those of a crimson color, which the French jewellers call 'Jacinthe la belle.' There is also a yellow variety resembling amber so closely that it cannot be distinguished from the latter, except by its hardness or by analysis. The best specimens of the zircon come from the island of Ceylon. The colorless variety is frequently set among clusters of diamonds by dishonest jewellers, where none but an expert could discover them. Many zircons are found on Cheyenne Mountain, but gems very rarely occur there. There is an ancient superstition which says, referring to a person who carried one, 'He was wont to wear a zircon for the purpose of procuring sleep, to which purpose it did seem to conduce.' What follows zircon in your collection?"

"No. 17, labelled 'Quartz Crystal,'" said Tom.

"I see; and a very important mineral it is. In chemical composition quartz is an oxide of silicon. When pure it is colorless, but it is found in various shades of yellow, red, brown, green, blue, violet, and black. It is a constituent of many rocks, and takes on more forms and colors than any other mineral. Quartz occurs in three varieties: first, one known

under various forms as rock crystal, amethyst, rose quartz, and smoky quartz. Second, the variety which is distinguished by a waxy lustre, including the minerals known as chalcedony, carnelian, prase, heliotrope, agate, agatized wood, onyx, and sardonyx. Third, the opaque variety, comprising jasper, flint, and basanite or Lydian stone. The latter is the touchstone of the jewellers."

"Pardon me if I venture to interrupt you for a moment, uncle," said Tom. "I should like to know how the jewellers use the touchstone."

"Jewellers have two sets of needles," answered Uncle Ben, "one made of gold, the other of silver. These are of a known fineness, ranging from six carats to twenty-four carats,—the latter being absolutely pure gold or pure silver, according to which set of needles is in use at the time. The substance to be tested is rubbed across the Lydian stone, on which it leaves a mark. Then that one of the needles which resembles it in color is rubbed across the stone and the colors of the two marks are compared. Of course, brass could be made that would give the exact color of any of the needles, and might deceive the jeweller if he were satisfied with the test by comparison alone; but he covers each streak with a few drops of nitric acid, which acts to destroy the brass while it leaves the gold unchanged."

"Thanks, uncle," said Tom. "That is very interesting, indeed. But I fancy you have not yet got through with No. 17."

"Why, no," said his uncle. "Quartz is a large sub-

ject. Volumes could be written on it, and an extensive collection could be made of specimens of this substance of which no two would be alike. At Sioux Falls, Dakota, there is a mass of compact quartz, of much beauty and variety of color, which is quarried and polished for ornamental purposes, and sold as 'Sioux Falls Jasper.' The tints are chocolate, brownish-red, brick-red, yellow, and cream color. The pilasters of the German bank in St. Paul, Minnesota, and the columns in the doorway of the Chamber of Commerce building in the same city, are made from this compact quartz.

"The Romans made use of large crystals of quartz to produce wine-jugs, cups, vases, and other vessels. You may imagine, from the hardness of the material, that to work it into such shapes must have been a difficult and costly process. Nero possessed two beautiful drinking-cups made from pure quartz crystal, one of which cost him a sum equal to three thousand dollars of our money. When he was informed of the loss of his empire, he is said to have broken them in his anger. We are told that it was at one time the fashion in ancient Rome, for the sake of their refreshing coolness, for ladies to carry spheres of quartz in their hands. The crystal, being a good conductor of heat, readily relieved the hands of their warmth and moisture. In the same way, in modern Japan, artistic embroiderers keep their hands free from perspiration by the use of a crystal ball. In truth, no small amount of human labor has been expended upon quartz, of which probably the finest

work in existence made from a single crystal is an urn which is kept among the French national jewels. It is nine and a half inches in diameter and nine inches high. But, as I told you, a volume could easily be written on the subject of quartz. I might go on with its story if I had time and we were through with the box; but perhaps we had better turn now to No. 18."

"Well, we have not got rid of quartz yet, it seems," said Fritz, presenting the specimen. "This time it is 'Rose Quartz.'"

"I see. This, as I have already said, belongs to the same variety as rock crystal, though it is scarcely ever found in a crystallized form. It has, as you may perceive, a peculiar fatty lustre; and it is rare to find a specimen transparent enough to cut into gems. Its rosy tint is due to iron and manganese. It has no particular interest separate from quartz in general, so you may delve into your box again."

"Gypsum comes next," said Tom. "That makes me feel at home, for we have large bodies of it in Ohio, where it is made into plaster of Paris. I am taking it for granted that this is the same substance."

"Yes; there is only one gypsum, wherever found, though it may vary in appearance, and its principal use is in the manufacture of plaster of Paris. It is also employed as a fertilizer. There is an interesting story which relates that George Washington, when a boy, placed some gypsum on a hill-side in such a manner as to spell his name. As all sulphates (gypsum, I would say, is a sulphate of lime) attract

moisture, the grass grew stronger and taller where the gypsum had been placed, and as a consequence the name stood out in bold relief. Aside from the common commercial gypsum, there are several very handsome varieties, including alabaster, satin-spar, and selenite. The latter is a transparent, crystallized variety. Satin-spar you have already had described. Alabaster takes its name from Alabastrom, a village in Egypt, and is a beautiful, translucent substance, from which works of art are made that somewhat resemble marble."

As he stopped speaking, Fritz turned to the box again, replacing the specimen of gypsum and taking out the next, which was marked No. 20 on the list.

"It is labelled 'Iron Pyrites,'" he said. "I think you spoke to us on that subject while describing gold quartz. You may remember that I took for gold the bit of pyrites on the specimen."

"I am glad, Fritz, that you have not forgotten your lesson. I did at that time say something about iron pyrites, I remember, but must now give you a little more information on that subject. There are few minerals more widely distributed, it being found in nearly all parts of the world, and abundantly in our own land. Gold often comes with it, especially in our Western States, where it is rare to find iron pyrites that does not contain some gold. In fact, many of the mining companies obtain all their gold from pyrites. In the bituminous coal mines of Pennsylvania it occurs in the form of scales, plates, and balls, and is occasionally so brilliant that it is em-

ployed in jewelry. One of my lady acquaintances wore a necklace of pyrites to a ball one night, which was seen from a distance by a society newspaper reporter, who heralded his discovery to the world by the following item: 'Mrs. —— wore a diamond necklace which was the cynosure of all eyes, and she was justly named the Queen of Diamonds.' Perhaps I ought to add that the reporter was near-sighted.

"Before we put this specimen away, it may be well to demonstrate to you the difference between iron pyrites and copper pyrites. Here, take my knife and try to cut this specimen. You will observe it is hard enough to turn the edge of the blade. Now take the specimen of copper pyrites from the box and try the knife on it. You see that it is easily cut or streaked, and that the powder of the streak is of a greenish black color. There is another way of showing the difference in hardness. Here is a plain glass tumbler. Rub the copper pyrites across it. You see that it does not scratch the glass. Now draw the iron pyrites across the tumbler."

Fritz did so, and uttered an exclamation of surprise. "Why, Uncle Ben, I have ruined the tumbler. See, I have made two great scratches on it. I declare if the pyrites has not cut it as easily and as perfectly as a glazier's diamond. And as deeply too, I fancy."

"That is a very good practical demonstration," said Uncle Ben. "The pyrites is very hard, and miners often use it to cut panes of glass of the

proper size to fit the windows in their cabins. I may say, in fact, that the use of pyrites is much more extended than is generally supposed. Notwithstanding the immense output of the United States, thousands of tons are imported annually from Spain, Portugal, and other countries for use in this country. Being a bisulphide of iron, it is much employed in the manufacture of sulphuric acid. Sulphur is also obtained from it, and it is used in making alum. As for copper pyrites, it is the most abundant of the copper ores, and, perhaps, a third of all the sulphur employed in the world is derived from it. So much for pyrites. What comes next?"

"Ribbon agate," said Tom. "But Harry told us about that when we were talking of the agates, so No. 22 comes next in order. This is labelled 'Onegite.' There is nothing in the name to suggest what it is."

"No. In fact, it is a composite substance, consisting of capillary crystals of the mineral gothite which have penetrated quartz. Until lately Russia was the only locality where it could be obtained, but it has recently been found in large quantities at Florrisant, Colorado, where it was at first described as a new species. There is considerable demand for it from collectors of minerals, and you were fortunate to obtain such a fine specimen. The gothite, which penetrates the crystal, is a hydrous sesquioxide of iron. By transmitted light its color is a blood-red."

"The next specimen," said Tom, taking it from the box, "is called 'Quartz Geode in Lime.'"

"I see. This is also found at Florrisant, and in the vicinity of Fort Collins, Colorado. It might be described as a hollow agate whose interior is lined with crystals of quartz. These geodes are interesting to the student of mineralogy, in showing the growth of agate. The geode itself is a mere hollow lump of indurated or hardened matter into which the quartz has made its way in solution. Geodes are found in all stages of growth, from where a thin seam of chalcedony is deposited on the outer edge of the mass to the full-blown agate filling the entire cavity. Sometimes they contain a solid movable nucleus, or are filled with earthy matter. Unscientific people often call them 'potato stones,' from their shape and outside appearance."

"Here we are at No. 24, the last specimen in the box," said Tom, regretfully. "As I hand you this specimen, I feel as though you were going to preach a funeral sermon."

"And it makes me feel like the chief mourner," broke in Fritz. "I should not object if the number were doubled."

"There is no need for this to be the last," said Uncle Ben. "The interest you have taken in these specimens encourages me to continue. If you really care to go on, we may next start in on my large collection. We might begin with the useful metals, learning where they are found, their various uses, and how to test them in a simple manner. And as Inez and Eva are rested from their long journey, I am sure they will aid me by giving you an account of

what they have seen in other countries. Inez, you must know, is quite a collector of precious stones and gems, and gathered a considerable number of them on her late trip. She can tell us all about them."

"That will be delightful," exclaimed Tom.

"Why, yes," suggested Fritz, "I for one have a soft place in my heart for precious stones, hard as they are. And, by the way, you have often spoken of the hardness of minerals. Of course, I know what that means in a general way, but I fancy you mineralogists give it some particular meaning."

"I am glad you asked that question," answered their uncle. "I had fully intended to explain it before. It is to this property of hardness, possessed in a high degree by precious stones, that we are indebted for the durability of their lustre. Many years ago an Austrian mineralogist named Mohs invented a scale of hardness for testing minerals, which is in general use by mineralogists. The scale is as follows, beginning at the hardest known mineral and descending to the softest: diamond, 10; sapphire, 9; topaz, 8; quartz, 7; feldspar, 6; apatite, 5; fluor-spar, 4; calcite, 3; gypsum, 2; talc, 1. To find the hardness of any stone, we have only to rub it against another of known hardness. For instance, if any particular specimen is found to scratch quartz, but is in its turn scratched by topaz, it is evidence that its hardness lies between the topaz and quartz, and may be estimated as seven and a half on the scale. The diamond scratches all other stones,

and is, therefore, given the place of honor on the scale. No doubt you can buy a box of minerals known as the scale of hardness, at the same store where you purchased your box of specimens."

"I shall try to do so," said Tom, "and the larger the diamonds and sapphires they give me for my money the better satisfied I will be. I would not complain if they were even as large as potato-stones. But we are forgetting our funeral sermon on No. 24. 'Opalized wood' is its epitaph."

"Don't be too funny, Tom," said Fritz. "Not so early in the day, anyhow."

"This is much the same thing as petrified wood, which you have already been told about," said Uncle Ben. "Its only differences are that it contains more water and has a semi-opalescence. That ends our lesson for the day and our dealings with the box of specimens. Now, if you will excuse me——"

"Certainly," cried the boys together, "and thank you heartily into the bargain."

They left the room as they spoke, while Mr. White seated himself at his desk and was soon intent over his papers.

CHAPTER IV.

METALS OF GREAT VALUE.

DURING the several days that followed, Uncle Ben and his son Harry accompanied their visitors in carriage rides through the residence portion of the city and to all the attractive spots for which it is famous. The youths were loud in their praises of the many handsome residences and the magnificent public gardens and parks.

Fritz, whose intention it was to become a lawyer, informed his uncle that he proposed to pay particular attention to mining law, with a view to future practice in the West.

Tom, at this, drew his attention to the multitude of lawyers in the city, while Fritz retaliated by asking Tom if he had noticed the myriad of doctors' signs in town. Tom was studying medicine and expected to graduate as a doctor of medicine. But Uncle Ben settled the question by assuring them that there was plenty of room at the top in both professions ; all they had to do was to reach the top ; but this "all," as Tom somewhat ruefully remarked, was a very big one. The top, he said, was high, and the climbing rough. They both, however, declared that they would do their best to get there.

At the end of this interval of sight-seeing, the de-

sire to resume their lessons returned, Uncle Ben having informed them that his collection of minerals had been replaced in its cabinet and was ready for use.

"It will take us some time to go through it," he remarked, "and my story will not be quite free from dryness, I promise you. Gaining knowledge isn't altogether play. There is toil connected with it. But Inez has promised to brighten up our dull talks now and then by telling you something about coins, stones, and gems, illustrated from her handsome collection. I am sure you will find her more entertaining than I am likely to be."

"I should not care to say that," answered Tom, as the party made their way to the library. "You have not tired me yet, and I do not fear that you will."

"And though, as I said, I have a soft place for precious stones," added Fritz, "I am quite ready to hear more about your every-day minerals, such as gold and silver, for instance."

As they spoke they entered the library, where stood the tall and handsome cabinet, of some dark-colored foreign wood, in which were stored the choicest specimens of Mr. White's large collection of minerals. He opened it, remarking,—

"Perhaps we had better begin on the subject of gold, which I fancy Fritz looks upon as the most valuable of all the metals."

"Well, isn't it?" asked Tom, in a tone of some surprise.

"Not by any means. There is quite a list of

minerals that exceed gold in price. Gold is worth twenty dollars sixty-seven cents and eighteen one-hundredths of a cent per ounce, or about two hundred and forty-eight dollars per pound. There are ten metals of a much higher price: prices that will probably astonish you; yet I will give you market quotations only.

"First on the list comes vanadium, which is worth two thousand two hundred and forty dollars per pound. It is a silvery, brittle metal, of rare occurrence. It was originally discovered in iron ore by a Swedish chemist, who named it from Vanadis, a Scandinavian goddess. Its principal use is said to be the giving to French silks that beautiful sheen which no other silks possess. It is also employed in making a pigment for producing brilliant colors on fine china-ware. These are the only uses I know of, though it may be employed in other ways."

"Well! that is astonishing," declared Fritz. "I did not dream that there was any substance on earth, unless it was the diamond, that was worth so much money as that. When I go to wishing for riches again, I will wish for vanadium instead of gold. It counts up faster."

"Gold is rather a cheap material," said Uncle Ben, smilingly, "and will grow cheaper if the finds of new diggings keep on. The next metal in the scale of cost is rubidium, which is valued at one thousand eight hundred and twenty dollars per pound. It is a reddish metal, and is mostly obtained from mineral springs. It belongs to the same family

of the metallic elements as cæsium, sodium, lithium, and potassium. Following it in price is strontium, which is valued at one thousand and fifty dollars per pound. It is of a whitish yellow color, and is malleable and ductile, being somewhat harder than lead. It is obtained from the carbonate of strontium or strontianite, and is named from the village of Strontia, in Argyleshire, Scotland. When manufactured into nitrate of strontia, it is employed in giving that beautiful red color that we see in fireworks and in the tableau at theatres."

"Is that so, uncle? And do they waste a metal worth a thousand dollars a pound merely to get a red color?" queried Fritz. "I have seen the crimson color you speak of, and wondered how it was made."

"It is a very simple process. One of the stage employés stands in the wings with a shovelful of glowing charcoal, on which he shakes from a pepper-box a little of the nitrate of strontium. It at once flames up in the rich color you have seen."

"I am very much indebted for that information," said Fritz, "and will make use of it in our private theatricals when we get back to Ohio. I suppose the nitrate can be had at less than a thousand dollars a pound, if they dust it at that rate out of a pepper-box."

"I don't fancy it matters," answered Tom, "for it is my opinion that we will not have private theatricals any more. Last winter, in one of our plays, Fritz played the part of a lover and a young married

lady played the part of his adored one. The next day her husband sent the manager a note, saying that his wife would not be allowed to act with that company in the future. His explanation was that 'the kissing was too natural.'"

Mr. White and Harry laughed heartily at Tom's statement, while Fritz grew red in the face at the recollection. To relieve him from the embarrassing situation, Mr. White returned to his story of the metals.

"Next to strontium in value comes lanthanum,' he said. "It is valued at nine hundred and ten dollars per pound, being worth considerably more than three times as much as gold. It is a rare metal, obtained from the very rare mineral cerite, which is of a pale rose-red color Lanthanum is of little interest or importance, but I have been informed that physicians use it in some form as a medicine.

"Next on the list in value is tantalum, worth six hundred and eighty-two dollars per pound. It is said that it was so named from the tantalizing difficulty of its analysis. Thus far it has only been obtained as a black powder, mostly from the mineral tantalite, though other minerals yield it in small quantities.

"Next comes ruthenium, valued at five hundred and forty-six dollars a pound. It is a hard and rare metal found only in association with platinum. It was first discoved in Russia, and takes its name from Ruthenia, the Latin name for Russia. The next in value is——"

"Pardon me, uncle," said Fritz: "but is there no use for ruthenium?"

"Why, it is said that, on account of its hardness, it has been employed in the manufacture of surgical instruments, and also as tips on fine gold pens. Perhaps you have noticed those tiny brilliant points."

"Yes, uncle, I have, and have wondered what substance they were made from."

"The next most valuable metal is lithium, which is quoted at four hundred and eighty dollars per pound. It is the lightest of all known metals. It has a silvery-white lustre, and is so light that it will float on the lightest of the liquids. As regards its uses, carbonate and citrate of lithium have been successfully used in the treatment of rheumatism, gout, and other diseases. Indium, which comes next in order, is quoted at four hundred and fifty-five dollars per pound. This metal was discovered by Professor Richter in 1863, and is white and much brighter than silver, though approaching it in lustre. It is soft, ductile, and not sensibly oxidized in the air. I am not aware that any practical use is made of it. Niobium or Columbium is a rare metal extracted from the mineral columbite, which is also very rare. A beautiful, indelible blue color is made from it. Niobium is valued at four hundred and fifty dollars per pound."

"That must be rather a costly color?" said Tom.

"Well, no not necessarily so; a very small quantity of the metal may go a long way in the manufacture of the color. In illustration, I may say that

fifty cents' worth of copper can be made into a solution that will stain one thousand tons of quartz."

"Father," said Harry, who had thus far listened in quiet, "have you not forgotten to mention another metal more valuable than gold? I refer to yttrium."

"That is a fact, my son. And as I have overlooked it, I will leave it to you to tell the boys about yttrium, while I light a cigar and have a smoke."

"That looks like getting the joke on me," laughed Harry. "You are escaping in smoke from a hard subject. The fact is, boys, this is a metal that neither of us knows much about, although it is valued at eight hundred and twenty dollars per pound. All that I can say about it is, that it is one of the rare metals and is found in Sweden. It is of a gray-black color and of a scaly texture. The silicate of yttrium is now in great demand for purposes of electric lighting. And now, father, while you are having your smoke, we will take the opportunity to have our run. I fancy Tom and Fritz will want time to digest their morning meal of high-priced metals."

Whether for this reason or not, the boys were quite ready to follow Harry's lead, and Mr. White was soon left alone to the enjoyment of his cigar.

CHAPTER V.

GOLD AND ITS PRODUCTION.

MONDAY morning, Uncle Ben arose bright and early, and took his habitual walk before breakfast, after which meal he was ready to meet his youthful students in the library and continue his lessons on minerals. His nephews, pencil and note-book in hand, were as eager as usual for the conversation to begin. Opening the cabinet, Mr. White took from it a tray of specimens, which he deposited upon the library table, each of them then taking their accustomed seats. Harry was absent, perhaps not caring to listen to what was to him an old story.

"How did Harry get along with yttrium?" asked Uncle Ben.

"Very well, indeed," said Tom. "He told us a good deal more than we knew on that subject; but that he might easily do, since we knew nothing. I, for one, was glad to know that it is in use for electrical purposes, as I hope to give some time to electrical science while in college."

"The most of what he said was that very little is known about it," said Fritz. "On reference to my notes, I find that Harry said it was the silicate of yttrium, and not the metal itself, that is used for electric lighting."

"I have it the same way," rejoined Tom, looking at his latest notes. "Fritz understands those things better than I do, as he has been reading up on chemistry."

"That is a good example for you to follow," said Uncle Ben. "Chemistry is, as I may say, the very backbone of mineralogy. And now, since we have disposed of the most costly metals, it may be well to have a little talk on gold, which in practical value stands far ahead of all those we talked about at our last sitting. Here is a nugget of gold from a Beaver Creek placer-mine, which you can examine at your leisure. I may say that this subject is practically exhaustless, and we could perhaps converse on gold during your entire vacation. But it is not necessary to go into the minute details of the subject, and I shall endeavor to be as brief as possible, at the same time giving you such information as I can about it in few words. Gold, as you know, as everybody knows, in fact, is a metal of a bright yellow color. But, perhaps, you do not know that it is the most ductile and malleable of all metals, and one of the heaviest. It occurs in nature in a metallic state, and when found is always alloyed with silver. Pliny, one of the most celebrated writers of ancient Rome (born A. D. 23), says that when gold contains one-fifth part of silver it is called electrum. But the proportion of silver greatly varies, and is often quite small.

"Gold is sometimes found crystallized in the form of a cube, also in grains and thin, flat scales; at

other times it is massive, forming lumps of irregular shape and now and then of considerable size. Such lumps are called nuggets. This is one of ordinary size." He pointed to a small yellow lump of metal on the table. "Gold is never found in a perfectly pure state. The gold of California, for instance, yields out of one thousand parts an average of eight hundred and eighty parts of pure gold. The other one hundred and twenty parts are a mixture of silver, copper, iron oxide, and dirt. Australian gold is richer, yielding an average of nine hundred and twenty-five parts of pure gold out of every thousand, the remaining seventy-five parts being similar to the impurities found in California gold. The original home, or nesting-place, as I may call it, of gold is in the quartz veins that exist in metamorphic rocks."

"I beg pardon, uncle, for interrupting you," said Fritz, "but I should like to know what is meant by metamorphic rocks."

"A metamorphosis, your dictionary will tell you, means a change of form or structure. The metamorphic rocks are those that have undergone a change, as where the texture has been rendered more or less crystalline by the action of heat from below, pressure from above, or chemical influence. The lowest or non-fossiliferous stratified rocks, those that were formed early in the geological ages, such as porphyry, granite, slate, etc., are the ones usually designated by this title; though it also includes some of later origin."

"Thank you, uncle; I have made a note of that," rejoined Fritz.

"Gold is always very irregularly distributed," continued Uncle Ben. "It is never found in continuous bands of metal, as in the case of many other metallic ores. As found in quartz it occurs in strings, scales, plates, and nuggets; but most commonly in tiny specks that are invisible to the naked eye. It is seldom that I can see any gold in the quartz from my mine except by the aid of a magnifying-glass. Here is a specimen from the mine that will probably assay more than one hundred dollars per ton in gold. Tom, you have young eyes; examine it and see if you can find any gold."

Tom took it and subjected every part of it to a close scrutiny.

"There is nothing in it that looks like gold, so far as I can see," he said. "The specimen seems to be covered with iron rust."

"Let me look, Tom," said Fritz, taking the specimen from his hand and studying it intently. "If there is any gold in that I fail to see it," he at length acknowledged; "though, of course, uncle, I do not doubt your word."

"Now take my magnifying-glass, Tom, and examine it through that," said Uncle Ben.

"Well, I declare, that does make a change! It is now spangled all over with tiny specks of gold. Look, Fritz. Are there any pyrites in this ore, uncle?"

"Not a trace of them," was the reply. "This is

what we call free milling ore. There is no doubt that it at one time contained pyrites of iron, but these have undergone a chemical change, and been converted from bisulphide to oxide of iron. That is why the rock shows stains of iron; the iron rust that you noticed."

"But isn't it wonderful how this magnifying-glass shows up the gold?" said Fritz, with much animation. "How in the world did the gold get into that solid rock? That is the mystery of the matter to my undeveloped intellect."

"It is a mystery to many more developed intellects," said Uncle Ben. "There are many theories to account for it, and objections to all of them. The fact is that no single theory will fit all cases. Yet the origin of gold and silver and other minerals, and the manner of their formation and deposition, are questions of vital importance to the miner, one of the principal reasons of this being that he may be able to arrive at a satisfactory solution of the probable depth or extent of the mineral veins. The generally accepted theory is that gold and silver ores are of an aqueous origin. One scientist says, referring to the fissures that contain the metals, that they were formed by an expansive force acting from within the earth, and were subsequently filled with foreign matter, injected in a fluid state, and afterwards slowly crystallizing. Another theory is that the metallic ores were deposited in open fissures by the magnetic currents that pass through the earth from pole to pole. But it is useless to continue on these

theories; they are too numerous and too unsettled for us to spend much time on them."

"I thank you very much, uncle," said Fritz; "and must beg pardon for interrupting your interesting discourse by my questions."

"No pardon is needed; that is just what I wish you to do," said Uncle Ben. "Do not hesitate to interpose a question at any and all times. I cannot well think of all things, and every question may suggest a reply that will be valuable to you. Have I answered your question on the origin of gold satisfactorily?"

"Quite so. You have told me that nothing is positively known, and that the theories are little more than guesses. It is hardly worth while to spend time on a theory of to-day that may be overturned by to-morrow's theory."

"Very well put, Fritz," said Uncle Ben. "I may say here, however, that the waters of the ocean have been found to contain gold and silver in solution. A very minute quantity for a ton of water, it is true; it would never pay to mine the ocean; yet the quantity is vast when we take into account all the waters of the seas. Possibly the gold and silver deposited in rock fissures may have come from sea-water; but that is only another of the guesses."

"And is that the reason that sailors do not care to drink sea-water?" asked Fritz. "Are they afraid of having gold and silver deposited in their interior?"

"No; it is salt that they are afraid of," said Uncle Ben, with a smile. "It is the abundance of salt that

makes the abundance of water of no use to them; simply a tantalizing mockery."

"Many thanks. And now I won't ask another question for five minutes."

"You may do so in a minute if a good one comes to you. Never go ignorant for lack of asking. But to return to the subject of gold. Besides its occurrence in quartz veins, large quantities are mined in the placers or alluvial washings, and the supply of the world is mostly found in such mines. They are located on the slopes of hills or mountains whose rocks contain gold-veins, and also in the adjacent valleys and ravines."

"There, uncle, you have started a new question in less than a minute," broke in Tom. "And I need not ask pardon for propounding it, for you have told us that questions are what you want. You have told us what quartz mines are; I should like to know what are placer mines. Was that placer gold we got by panning on Cherry Creek?"

"Yes. And it is an interesting story how it got there. The original locality of gold, that is, so far as we know, is in the quartz veins of the mountains, where the gold has somehow made its way into the solid quartz. But, as I suppose you know, all mountains are subject to denudation,—that is, to being worn down by the rains, which gradually carry off the substance of great mountain chains.

"Streams and rivers arise from these rains, and much of the substance of the rocks is borne down their channels. It is not dissolved, but is simply

carried by the water, and gradually sinks to the bottom, where it forms layers of mud, sand, and gravel. The gold which is washed out of the quartz veins is carried down stream in the same way, and, on account of its great weight, sinks to the bottom early in its course. There is very little of it at a time, but this goes on for ages, and at length considerable quantities of gold are accumulated in the river-beds, or in the gravels deposited at the sides of streams where the channel was once wider. These are what we call placer veins."

"Well, that is certainly interesting. So the gold we got in our pan found its way into the creek bottom in that fashion? It seems to me that I have heard or read somewhere that rivers now and then disappear, or cease to flow, through a change in the level of the country, and that gold is found in their old beds."

"Very true," said Uncle Ben. "A notable example of this is the great blue lead of California, which is the bed of an ancient river, though it is now covered in places by volcanic lava many hundreds of feet in depth. It has been proved by geologists that the contents of this dead river came from the far north, from the fact that it contains a peculiar variety of quartz that does not exist in California. Nearly three hundred and fifty millions of dollars' worth of gold has been taken from this dead river, and it is now producing about seven millions of dollars in gold annually. It has been traced for a distance of seventy miles, and shows a regular grade of about thirty feet to the mile."

"How do they know that it is an ancient river?" asked Fritz.

"That there is no doubt of," answered Uncle Ben. "The explorations of miners show it to have all the marks of a former river. It has a long course, a nearly uniform width, a nearly straight channel, water-worn gravel which must have been carried a long distance, and flat stones which point down stream as a current would have placed them. It displays also a uniform descending grade, and there have been found in it drift-wood which is unmistakably water-worn, and trunks of trees with the butts up stream. There are many other evidences which I do not now call to mind."

"I, for one, should not think of asking for more," said Fritz. "I am not like Oliver Twist,—always wanting more. I know when I have enough, and you have given quite enough to satisfy me. There must have been a lively time there once, though, for volcanoes to throw out lava enough to bury this river so far out of sight."

"You are quite right there," said Uncle Ben. "At some time in the past volcanoes must have been very active on the Pacific slope, and thousands of square miles of deep beds of lava exist there now. It is interesting to know that the course of this 'blue lead' or ancient river is the same as that of the Sierra Nevada mountains, northwest and southeast, while the rivers of to-day all flow at right angles with the mountain range. The generally accepted theory is that the upheaval of the Sierra Nevada range of

mountains changed the course of the old river, and that it was subsequently covered by the flowing lava. The waters of the Frazer River in British Columbia, of the Columbia in Oregon, and of the Sacramento in California, may in former times have emptied into the now dead river. The Columbia and Frazer now break through narrow openings in the mountains. But if these were closed, they would be made to flow southward.

"Now let us return to the subject of gold. Whatever may have been said of the evils that have been inflicted upon humanity by the thirst for this metal, one fact stands out prominently, which is, that just in proportion to the abundance of the precious metals the arts and sciences have flourished, trade and commerce have increased, the area of civilization has been extended, and the comfort, intelligence, and freedom of the masses have augmented. I may further say that there is no other industry that exceeds gold-mining in certainty of success, if it be given capable and intelligent management.

"Picks, pans, and shovels were the first implements used in the modern search for gold. The pans employed were about the size of ordinary milk-pans. These were filled with the gold-bearing earth, and then were sunk a few inches deep in water. When the dirt was completely saturated it was stirred by the hand, and the settling of the gold was facilitated by a circular motion of the pan. The top dirt was then gradually washed off. This operation was repeated until nothing but gold and black sand were

left in the pan. The so-called black sand, which always accompanies the gold, is an oxide of iron, and may be separated from the gold by the aid of a magnet."

"Harry says that I am a pretty good panner," broke in Tom. "I have experimented almost every day since our trip to Cherry Creek."

"It requires some experience," said Uncle Ben, "to save all the gold, and to prevent it from escaping towards the close of the operation. Yet the knack is easily acquired. The pan was succeeded by the rocker, an instrument introduced from Chili. It very much resembles the old-fashioned baby rocking-cradle. The earth is first thrown upon a screen, and water poured upon it with a dipper, while the rocker is kept in steady motion. The fine dirt passes through the screen, carrying the gold with it, and then over an inclined apron under the screen, from which it falls on to the inclined floor of the rocker. In its onward course it is made to pass over two cross riffles, which retain any small particles of gold that may have escaped from the apron. The coarse stones which are left in the screen, now freed of gold and earth, are thrown out, the screen is replaced, and the cradle is ready for another bucket of earth.

"The 'long tom' was the next instrument brought into use. This consists of a box or sluice with two sides and a bottom; it being usually ten or twelve feet long and twelve inches wide, while a stream of water is kept constantly running through it. The earth is thrown into the box, which is set at a suffi-

cient inclination to allow the force of the water to carry the sand and stones to the lower end. Here it falls upon a perforated sheet-iron screen, that will only allow small particles to pass through. Under the screen is an inclined box with cross riffles to retain the gold. The stones that are too large to pass through the screen are shovelled to one side.

"In time the long tom was succeeded by a string of sluices, which were used without the addition of the perforated screen. Hydraulic-mining, which is considered the perfection of placer-mining, was next introduced as a means of moving gravel deposits containing gold. Many of these deposits are hundreds of feet in depth, having been formed by flowing water during long ages of past time. Where they are extensive, with water plenty and convenient, they pay to work, even though the gold present does not exceed one-quarter of a cent to the cubic foot of earth. Most of them, however, yield more than that."

"That seems a very small output for the labor," said Fritz. "I should want my mine to do considerably better."

"It wouldn't pay very well, that is a fact," said Uncle Ben, "but for the vast masses of earth moved I will give you an illustration. One hydraulic placer-mine last year washed in one month forty thousand yards of earth, which yielded only eight grains of gold, or about thirty-two cents per cubic yard. That is to say, all this enormous mass of *débris* was thrown down by the force of the water and passed through

the sluices and deposited in the valley below. Gold being worth two hundred and forty-eight dollars per pound, it will be seen that in round numbers a fraction over fifty-five and a half pounds of gold, worth nearly thirteen thousand eight hundred dollars, was obtained from the forty thousand yards of earth.

"Only in mining for gold could such small results be obtained , for, as a rule, other metals form the bulk of the ore that is treated,—silver as high as eighty per cent. ; lead, eighty-six per cent. , copper, eighty per cent. ; iron, seventy-five per cent. ; and tin, seventy per cent. Gold-mining, even with the most modern methods applied, is simplicity itself. It is all based on the fact that gold weighs nineteen and the gravel about two and a half,—that is, gold is more than seven times as heavy as the material that contains it.

"The only tool used to break up and convey the mass of gravel to the sluices is a stream of water under heavy pressure, and a skilful man to handle the nozzle. The gold, from its great gravity, falls to the bottom of the boxes, and is held by the barriers, while the lighter material passes on. Mountains have been moved in this way, and the rivers below filled with the *débris*. In a few years, a mountain of gravel that divided the town of Timbuctoo from Rose's Bar, in Yuba County, California, was washed into the Yuba River, and finally into the harbor of San Francisco, nearly two hundred miles away.

"It is a common belief that some Californian invented hydraulic-mining ; but, according to Pliny,

the Romans in Spain used a similar method. He writes as follows: 'Another labor, too, quite equal to this, and one which entails expense, is that of bringing rivers from the more elevated mountain heights, a distance in many instances of one hundred miles, perhaps for the purpose of washing these *débris*. . . . Then, too, valleys and crevasses have to be united by the aid of aqueducts, and in another place impassable rocks have to be hewn away and forced to make room for hollow troughs of wood. . . . The earth, carried onwards in the stream, arrives at the sea at last, and thus is the shattered mountain washed away; causes which have greatly tended to extend the shores of Spain by these encroachments upon the deep.'

"In many mines," continued Uncle Ben, "the gold is as fine as flour, and is then known as 'flour gold.' In that case quicksilver is placed in the sluices, and with this the gold amalgamates. After a clean-up, this amalgam of gold and quicksilver is placed in an iron retort, which is put in the midst of a strong fire. The heat drives the quicksilver off as a vapor, which condenses again into a liquid and flows from the nozzle of the retort, this being led into a tub of water. The use of mercury for amalgamating with gold was known to the Chinese and natives of India in ancient times."

"I am not very clear on the word amalgamate," confessed Tom. "Just what do you understand by amalgamating with quicksilver?"

"Oh, I see. I should have made that clear. An

amalgam is a compound of mercury or quicksilver with some other metal. Mercury has a strong affinity with, or attraction for, gold, and combines with it whenever they come in contact. This is a highly useful fact in gold-mining, which depends very largely on this principle of amalgamation. Most of the fine gold would float away in the water, but that it is held by the quicksilver in the bottom of the sluice. When the quicksilver is afterwards driven off by heat, the gold remains in its pure state. Hydraulic-mining, as I have said, is pursued on a very large scale, many of the mines using more than two thousand inches of water."

"I never before heard of water being measured by inches," said Fritz. "What is meant by that?"

"The miner's inch is an arbitrary measure of the quantity of water that flows through a given space in a certain time. It was adopted by the early California miners, and became one of the laws of the camp. The measurement differed, however, in almost every district, there being no common scale. In the generally adopted method of measuring, an inch of water is the amount that will pass through an opening one inch square in a plank two inches thick, while the water in the box connected with the opening stands level at a height six inches above the opening."

"Does the plank form the bottom of the box or the side?" asked Tom, as he made a calculation with his pencil on the cover of his note-book.

"The side," said Uncle Ben. "In other words,

it is vertical, and the water runs out in a horizontal direction."

"Then, if the opening was ten inches wide and five inches high, it would discharge fifty miner's inches of water?"

"Exactly," said Uncle Ben. "Gold exists in nearly all parts of the world," he continued. "During the year 1896 the amount of gold produced in the whole world was worth about two hundred and three millions of dollars. Of this amount the United States gave fifty-three millions, Australia forty-five millions, South Africa—which of late years has become one of the great gold-producers—forty-four millions, and Russia (or rather its Siberian province) twenty-one and a half millions. In 1897 it became known that the United States and Canada possessed what is likely to prove another great gold-yielding district. This lies along the course of the great Yukon River and its tributaries. So far the rich placers have been mainly confined to the valley of the Klondike, a Canadian tributary. But many rivers and creeks run into the Yukon, both in Alaska and Canada, and gold is likely to be found in numerous localities on both sides of the border. In view of the great rush of miners to that region, it is not unlikely to be discovered also on the streams flowing into the Arctic Ocean, and at other points in the northern section of the Rocky Mountains."

"What becomes of all this gold, uncle?" asked Fritz.

"The largest proportion is coined by the civil-

ized nations of the world, a very large amount is used in the arts, and millions of dollars in gold are hoarded away. But perhaps I have said enough about this subject. It is a prolific one, and I——"

"Excuse my interruption, uncle," said Tom, "but I would like to ask you a question before we let go our hold on gold. Is what we call gold-leaf really gold? But I think we have taken enough of your time to-day, and that we had best let that question lie over till to-morrow."

"As you will. And that reminds me that I have an engagement, which had escaped me in the interest of our talk," said Uncle Ben. "So good-by till our next session."

CHAPTER VI.

A LESSON ON PEARLS AND RUBIES.

TUESDAY morning seemed to come very quickly to the young students, whose interest in the subject of the precious metals had been greatly increased by Uncle Ben's lucid descriptions. Eager to go on with their lessons, they reminded him soon after breakfast was over that their talk on gold remained unfinished, saying that if he had the time they had the desire to go on with the subject.

"I cannot give you a long period this morning," answered Uncle Ben, smilingly, "much as I enjoy having such attentive and intelligent listeners. But we can at least answer Tom's question, which lies open since yesterday's sitting."

Seeking the library again, the two boys and their uncle took their usual places at the table, and the note-books and pencils came quickly out.

"Gold-leaf; see, uncle," said Tom, showing the words written at the top of his page. "That is the text for to-day's discourse."

"Yes," said Uncle Ben. "If I remember rightly, you asked if gold-leaf was really gold. Well, yes, it is gold, though not quite pure, it usually having some alloy. Gold-leaf is made entirely by hand, no machinery having yet been invented that will

accomplish what the workman does at the bench. The gold to be used for this purpose is melted and cast into ingots of an oblong shape, each weighing about two ounces, and three-fourths of an inch in width. The ingot is passed between polished steel rolls under heavy pressure until it is flattened into a ribbon one eight-hundredths of an inch in thickness, after which it is cut into pieces one inch square. One hundred and fifty of these square pieces are next placed between layers of gold-beater's skin."

"Pardon, uncle, but what is gold-beater's skin?" asked Tom.

"It is a very thin and delicate substance prepared from the outside membrane of the large intestine of the ox," said Uncle Ben. "After the gold is thus arranged, one hundred and fifty pieces piled one above the other, with a piece of the flexible skin between every two pieces of gold, the whole is enclosed in a case of parchment and beaten by the workman with a sixteen-pound hammer. The packet is so elastic that the hammer rebounds with each blow, but the gold gradually grows thinner and widens out under the beating. When the gold pieces have in this way been flattened until each has become four inches square they are removed from the layers of skin and again cut into pieces one inch square. A new pile being formed, they are beaten as before, but now with a lighter hammer. When they have a second time widened they are once more cut into quarters, and a third beating usually finishes the work. An ounce of gold beaten in this

manner will spread out to cover one hundred square feet. The sheets of very thin gold thus produced are finally placed in books made of fine tissue-paper, they first being trimmed into squares of three and a quarter inches each. Gold-leaf, when beaten into a sheet of the thickness of one two-hundred-and-fifty-thousandths of an inch, and held up to the light, appears to be of a beautiful green color; the reason being that gold of that thickness is really semi-transparent, a part of the light, as I may say, filtering through it."

"Yes, I have had that experiment shown me," said Tom. "I thought it very odd that the yellow gold seemed green when looked at in this way. Can you explain that, Uncle Ben?"

"You must bear in mind that only part of the light comes through," was the answer. "No doubt you noticed that the upper surface of the leaf was yellow, while the lower seemed green. That means that the yellow rays of the light were absorbed by the gold and were reflected to your eyes. These rays were filtered out, as I have indicated, and only the remaining rays passed through. These gave a greenish glow."

"Why, that is certainly very interesting,' said Tom, enthusiastically. "And does gold ever show any other color?"

"No, I think not; though the beautiful color called 'purple of Cassius' is made from it, but not from metallic gold."

"How is it made?" queried Tom.

"If we pour a solution of protochloride of tin into a solution of the chloride of gold, they will combine to produce the color thus named. Purple of Cassius is made into a pigment that is employed in painting on glass and porcelain."

"I have read in some book or other," said Fritz, "about Tyrian purple, which I think was at one time highly admired and very costly. Was that made in some similar way?"

"Not at all," answered Uncle Ben. "The ancient inhabitants of Tyre were celebrated for the splendid dyes which they produced, especially for their purple and scarlet colors. The purple was obtained by them from two species of shell-fish, known as the murex and the buccinum. The former was taken from deep water on the coast of Phœnicia and the other was gathered from the rocks near shore."

"Are not people often cheated by imitations of gold?" asked Fritz. "I have heard that they could be made so perfect in appearance that it took an expert to distinguish them from the genuine article."

"Why, yes," was Uncle Ben's answer. "Many alloys have been invented to imitate gold, but in most cases they can be detected at once by the simple process of smelling. I have here a pair of vases bought in Europe which certainly look like gold, but which are only heavily plated with that metal. Smell one of them, Tom."

"Why," cried Tom, whose face looked as if he had swallowed something unpleasant, "it has a

mighty disagreeable odor, much like verdigris, I should say."

"So it has," said Fritz, repeating the experiment. "Well, that is certainly a very easy test, if it always works."

"The copper or brass which underlies the gold plating will assert itself," answered Uncle Ben; "and if the vases were not occasionally washed, rubbed, and brightened, they would soon tarnish from the metallic oxides making their way to the surface. An artificial gold, which is much used in Europe, is made from these ingredients: pure copper, one hundred parts; tin, seventeen parts; carbonate of magnesia, six parts; muriate of ammonia, three-sixths of one part; lime, one-eighth of one part; cream of tartar, nine parts. The copper is first melted, and the magnesia, muriate of ammonia, lime, and cream of tartar are added separately and slowly by degrees. The mixture is then briskly stirred for about one hour, after which the tin is added in small pieces. This done, the crucible is covered and fusion maintained for one hour. The slag which forms over the top of the metal must then be carefully skimmed off, and the metal contents poured into a mould. The result is a very good imitation of gold, so far as color is concerned."

"I know that gold is not used in its pure state for mechanical purposes or for coining," said Tom; "it being usually or always alloyed with some other metal. Why is this done?"

"Because pure gold is a soft metal and easily worn," answered Uncle Ben. 'It would not stand the wear and tear necessary for its use in coinage or the arts. The gold coins of the United States contain, in every one thousand parts, nine hundred of pure gold, the other one hundred parts being pure copper. This greatly increases the hardness and resistance to wear of the metal. In the arts many beautiful alloys are made for various purposes. The addition of silver to gold yields an alloy which has a green tinge. Copper added to gold gives a brownish-yellow tint. Twenty per cent. of aluminum and eighty per cent. of gold, when fused together, yield an alloy of a beautiful ruby tint."

"Has gold ever been used as a medicine?" asked Fritz. "I know that some of the metals have."

"It is supposed that the institutes for the cure of the liquor habit use a solution of gold," said Uncle Ben. "In ancient times a substance named 'aurum potable' was esteemed a sovereign remedy for the cure of all diseases. It was a liquid composed of dissolved gold, which was mixed with the oil of rosemary."

"I am sorry to say," he continued, looking at his watch, "that my spare time is up, so we will have to end our lesson at this point. And, by the way, my daughters have bespoken your services for this afternoon. They have invited some girl friends to play progressive euchre, and hope to have both of you take part in the game. To-morrow Inez will reward you by showing you her collection of

precious stones and gems, and telling you something about them."

"I hardly think we need any reward for having an afternoon's session with the girls," said Fritz, "even if minerals are left out, and we have only clubs, spades, and hearts to deal with."

"You forget diamonds," suggested Tom. "We shall not quite get away from the mineral world."

"And the pearls and rubies of the girls' cheeks," rejoined Fritz. "After all, it will be a good introduction to our lesson on precious stones to-morrow."

With a laugh, Uncle Ben left them, saying, "I fancy you two can get along safely, even without my cabinet to back you up."

As progressive euchre is not our theme, we will pass over the doings of the afternoon and move on to the next morning, when the boys found their cousin Inez waiting for them in the library. As they did not have their grave Uncle Ben to deal with now, Tom and Fritz wasted considerable time with curious questions about two lovely girls whom they had met at the euchre party the day before, and about whom Inez did not hesitate to tease them.

They were two of the reigning belles of Denver, Jessie Elliott and Estelle her sister, daughters of a mining millionaire. Jessie was a beautiful blonde, tall and stately, with eyes of violet blue and a complexion like a ripe peach. Estelle was the exact opposite of her sister. She was *petite* in stature, and had black hair and dreamy coal-black eyes.

She was demure and modest in the extreme. Jessie looked straight at a person, with laughing, inquisitive eyes, while Estelle dropped her chin and slowly raised her large languishing orbs when spoken to. Their dispositions accorded with their manner, that of Estelle being shy and retiring, while Jessie was lively, quick at repartee, and with ready wit.

The two Ohio boys had been much taken with them, and grew so eager in their desire for information that Inez ended with a burst of merry laughter, declaring that she must certainly tell her young friends of the conquests they had made.

"But you have not told me your preferences yet," she said, with a sly glance at the confused boys. "Which is your choice, Fritz, Jessie or Estelle? Of course, if I give you first choice, Tom will have to take the other."

"Take Fritz's leavings! Not much!" exclaimed Tom. "But, as I am not in the market just now for either, suppose we let them go and pay our court to your precious stones."

"Instead of to my precious girls, eh?" she asked, roguishly. "How is it with you, Fritz? Do you also prefer the cold charms of my cabinet specimens to the warm charms of your late partner?"

"Why, in my notion the present always has precedence," said Fritz. "The girls are not here and the jewels are, so I vote for them."

"All right," laughed Inez. "The girls are pretty, but they are not jewels. I must tell them that. Now for our gems."

As she spoke, she opened her casket of precious stones and gems to the interested gaze of her cousins. The casket was in size twelve inches long, eight inches deep, and eight inches wide, the gems being arranged in rows in four drawers that fitted into the box, one over the other. The bottom of each drawer was lined with canton flannel, on which rested a glittering array of gems. When Inez threw back the lid of the casket, both boys stared in wonder and admiration at the rich and glowing jewels exposed to their view.

"How beautiful they are!" exclaimed Fritz, first breaking the silence. "I never expected to see such a magnificent display."

"Nor I, either," said Tom. "I feel as I think Sindbad the sailor must have felt when the great bird left him in the valley of precious stones and glittering gems."

Inez listened smilingly to their words of admiration, betraying much gratification at the effect her treasures had upon the minds of her cousins. She had hoped to dazzle them by the display, and was glad of her success.

"That row of clear stones in the centre," said Tom, pointing at those indicated; "are they diamonds?"

"All of them," said Inez. "They are arranged, you see, according to size. That large one weighs two and five-sixteenths of a carat, and the small one at this end only one-eighth of a carat. There are twenty-one of them in all, one for each year of my

age—as it will be two years from now," she added, with a laugh. "Each of them is of the first water, except the large one, which, you see, is a little off-color."

"Yes, I notice a decided yellowish tint," said Fritz, "though it is strikingly brilliant."

"It is called the canary diamond from its color," said Inez. "It is precisely the hue of the celebrated 'Stewart' diamond, of which I will tell you later on."

"Diamonds are the most beautiful of all gems, are they not?" queried Tom.

"Certainly the most beautiful of the precious stones," answered Inez; "but, I think, not of all gems. At any rate, the pearl is looked upon by many as above all other gems in beauty. It is not, strictly speaking, a mineral, but is the product of a shell-fish."

"I did not know that," confessed Tom. "Of course, you have pearls in your collection."

"Here is a row of them," said Inez, taking a second drawer from the cabinet. "I shall tell you something about them first, and then proceed with the precious stones according to their value. There is an old fancy worth repeating for its poetical character, though not for its truth. It is that pearls are produced by the oyster swallowing the dew early in the morning, the dew being converted by the animal into pearls. But it is now very well known that the pearl has no such fanciful origin, but that the oyster forms this beautiful gem in the effort to

get rid of an irritating substance that has insinuated itself between the shells. This substance may be a mere grain of sand ; in fact, sand is the most frequent substance found in the centre of the pearl when dissolved. The irritating substance is first covered by the animal with a smooth coating of membrane, over which it spreads a layer of nacre, or pearly substance, being the same material as that of which the shell is made. Sometimes the pearl is due to the perforation of the shell from the outside by an enemy of the oyster. With a plug composed of membrane and nacre the oyster quickly fills up the hole made, and the consequence is that a pearl is formed on the shell. The finest pearls are those found in the body of the animal, and these are supposed to have been due to the effects of some internal disease. They are nearly always round and symmetrical, though some are pear-shaped. I have only succeeded in getting two round ones. Do you not think they are handsome?" she asked, displaying them with some pride.

"I should say so," rejoined Tom, looking at them admiringly. "By the way, Inez, these two pearls are of a pretty pink color, different from the others." He pointed out the pearls referred to.

"Those do not come from the pearl-oyster, but are obtained from the common conch-shell found in great abundance on the Bahama Islands. That is, the shell is abundant, but not the pearls. Fine pearls of this color are in great demand in Europe, and are as highly valued as the white ones."

"On the Bahamas?" said Tom. "But where is the native home of the pearl-oyster?"

"The most extensive pearl-fishing is carried on in the Bay of Condatchy, in Ceylon," replied Inez, "where it extends for several miles along the coast. Pearl-oysters are found there hanging in clusters to the rocks at the greatest depths to which divers can descend. They are found in many other parts of the world, the most famous fisheries after those of Ceylon being at the Bahrein Islands, in the Gulf of Persia; at the Sooloo Islands, off the coast of Algiers; on several of the West India Islands; in the Bay of Panama, and in several places along the coast of California."

"Tom has been doing all the talking," said Fritz. "It is my turn now to play the heavy questioner. Here is a pearl with the shape of an idol and very heavy. I don't think this was built up around a grain of sand."

"Well, no. Grains of sand don't come in that shape," laughed Inez. "This is one that Harry brought me from China, where, as he tells me, pearls of this kind are made artificially, the little pearly idols having a ready sale among the superstitious Chinese. For a long time the making of these pearly gods was kept a profound secret in a few families, descending from father to son for several generations, but the process is now well known. In making them, advantage is taken of the habit of the oyster to cover with nacre any foreign substance within its shell. After capturing the oyster, these

persons force open the shells and insert a leaden image of the desired shape. The oysters are then placed in a wire-basket attached to a rope and buoy and sunk in the water, where they are allowed to remain for one year. They are then brought to the surface, and when opened the image within is found to be completely covered with pearl."

"Well, 'the heathen Chinee *are* peculiar,'" said Tom.

"And up to 'tricks that are vain,'" added Fritz.

"Don't be too funny with your quotations," admonished Inez. "How am I to play the part of a grave and reverend professor if you make me laugh. Take care how you disturb my gravity again, for I have some solid facts to tell you. I may say that pearls are considered one of the richest gifts of nature to man. Hindoo mythology gives them the highest origin, saying that they were created by the god Vishnu. When Pompey conquered Mithradates, he found in the treasury of that noted monarch a portrait of the king formed of pearls in mosaic, and several crowns of the same material. The ancient Mexicans also were lovers of pearls, which they must have obtained from the fisheries in the Bay of Panama, which I have mentioned. The early Spanish historians tell us that Montezuma had immense numbers of fine pearls, and that his palace was studded with pearls and emeralds. Pearls are largely imitated——"

"Just a moment, cousin," broke in Tom. "We don't want you to go over old ground, and Harry

told us all about the French and Roman imitations while you were on your way home from Mexico. But he didn't tell us anything about how they fish for pearls, and that is what I should like to know about. You call it 'pearl fishing;' but I fancy it is not done with hook and line, with a bait on the hook."

"No; the pearl-oysters are not good at taking the bait. They do not even nibble. It is called fishing, but the oysters are gathered in this manner. A boat puts out from shore with a number of divers and two helpers and is rowed to the fishing-grounds, where it is anchored. Then a rope, having a heavy rock or other weight attached to it, is let down from the boat for each diver. The divers clutch the weight and are taken down with it, taking good care to keep near it at the bottom. Armed with a long, sharp knife and a basket to put the oysters in, the search of the diver for the precious bivalves begins.

"Many of those who have become expert by practice have been known to stay under water fully two minutes. When the diver feels that he is about out of breath, he attaches the basket to the rope and paddles quickly to the surface, where he is pulled into the boat. His basket is then hauled up and emptied, and he is ready for another dive."

"Does he have to cut the oysters from the rock to which they cling?" asked Fritz

"Oh, no; they are easily detached by the hands."

"Then what does he want with his long, sharp knife?"

"He needs that to defend himself from sharks and other voracious fish that inhabit the tropical seas. In fact, the business of the divers is a very dangerous one. Quick as they are with the knife, they are often caught by sharks and devoured; the only evidence of their horrible fate being a crimsoning of the water around the boat."

"I declare," said Tom, with a shudder, "that when I go into business it will not be as a pearl-fisher."

"When I go after pearls," remarked Fritz, "it will be in a jewelry store. I don't quite expect to escape sharks even there; but they are of the kind that is satisfied with devouring the pocket-book. Now, while I have a high admiration for my purse, I have a higher one for my person."

"I warrant that," said Tom. "To change the subject, Inez, do pearls always keep their brilliancy?"

"No. After a period of years, they acquire a yellow tint from contact with the air, and also from persons wearing them next the skin. We are told by one of the companions of De Soto that, in order to satisfy the greed of the Spanish adventurers, the governor of Guaxale opened a sepulchre, and that from it he took a quantity of pearls of the weight of as many as six and a half or seven arrobas, though they were injured from lying in the earth and in the adipose substance of the dead."

"Nearly all the crowns of Europe," she continued, "contain pearls, and I will describe them at some future time. One of the finest specimens in

the world is in the Spanish regalia. It was found on the coast of Mexico, weighs one hundred carats, and is valued at twenty thousand dollars. Recently there has been a demand for black pearls, and one that weighed forty carats was sold in Paris a short time since for ten thousand dollars. At the World's Fair held in Paris in 1889, a set of black pearls was exhibited which was valued at twenty-two thousand dollars."

"Pearls, then, seem to differ in color," said Fritz. "What are their prevailing colors?"

"Mostly white and cream-colored, though they are found in all the various shades of gray, black, pink, rose-color, yellow, salmon, purple, copper-red, and steel-blue."

"And are the shells of the pearl-oyster of any value?" asked Tom.

"Oh, yes. Their interior layer is of a pearly lustre, and is known as mother-of-pearl. They are worth about five dollars per thousand, and are used chiefly as handles for fine cutlery."

"I hope you are not tired of our questions," said Tom; "for, somehow, one question suggests another."

"Go on; ask as many as you want. I suppose I have told you some things you know already, but your questions help to acquaint me with what you do not know."

"Oh, my question is not an important one. I only wished to know if mother-of-pearl was found in any other shells than that of the pearl-oyster."

"Oh, yes; but it is not usually thick enough for

purposes of manufacture. The only kind good for that purpose is obtained from the large oysters of the Indian seas. You, of course, have often seen it, and know how beautiful it is with its changing silvery, purple, and azure tints. These brilliant hues, like those of the pearl itself, are not due to the nature of the substance, but to its structure. The nacre is laid down in very delicate layers, and it is the action of these layers upon the reflected light that produces the iridescent effect."

"You spoke of the conch-shells of the Bahamas as yielding pearls," said Tom. "Are they produced by any other shells than the oysters and conches?"

"Yes; even by such common shells as the mussels of our American rivers. Some quite fine pearls have been found in mussels, and quite an excitement in pearl seeking has at times been produced on certain streams. But the returns have never made any one rich, and the fisheries have generally soon been abandoned again."

"Then you would not advise me to take up mussel fishing for a profession?" said Fritz.

"I am afraid you might have the luck of the Jersey shoemaker," answered Inez, with a laugh.

"Ah! what was that? Is there a story about the shoemaker and his luck?"

"An amusing one to everybody but the shoemaker," answered Inez. "This disciple of St. Crispin—I suppose you know that Crispin is the shoemakers' saint—got tired of pegging on soles and went pearl hunting in a stream near his home in

which pearls had been found. But there were none for him. He opened hundreds of shells, but not a pearl as large as a mustard-seed appeared. At length, in despair, he determined to go back to his soles and uppers, but first decided to treat himself to a feast of roast mussels. So, selecting some fine large ones, he placed them on a hot stove, and then, opening the valves, he swallowed the animals with a relish. But what was his horror, on opening the largest shell of all, to see before his eyes a pearl, magnificent in size and shape, but utterly ruined by the roasting it had undergone. The unlucky cobbler failed to relish that particular mussel."

"I should think so, indeed!" cried the boys in concert, as they broke into hearty laughter at the dilemma of the poor pearl-hunter.

"Well, I don't know but that we have pestered you enough about pearls," said Fritz, when he had regained his composure; "though we do not seem to have exhausted your stock of facts. You promised to follow your talk on pearls with a description of the precious stones, beginning with the most valuable, and we are waiting to hear what you have to say about diamonds."

"But you said the most precious," remarked Inez; "and no doubt you think that diamonds are the most valuable of the precious stones. They are not, however; rubies come first. To give you some idea of their comparative value, let me remark that a ten-carat ruby is worth ten times as much as a ten-carat diamond."

"Oh, now, Cousin Inez, can that be so?" exclaimed Tom. "I was not aware that rubies were valued so highly."

"I begin to suspect that the ruby in my shirt-stud is a bogus one," said Fritz, dolefully. "I only paid fifteen dollars for it, with the setting. Won't you please examine it, Inez, and let me know what you think of my bargain?"

Inez did so, looking at it with eyes of experience, while the expression of her face indicated her opinion before she spoke. "If the jeweller from whom you purchased this told you that it was a ruby," she said, "he simply told a falsehood. It is a manufactured stone, made in imitation of the ruby. It is what we experts call a doublet,—that is, it is composed of two parts. The top portion is a thin layer of garnet, and the bottom portion is nothing but red glass. Examine the girdle or edge of it with a magnifying-glass and you will see where it has been joined together. Then look further along the plane of jointure and you will fine several air-bubbles."

"That is rough on Fritz's ruby, about which he has been proud enough for two of his size," said Tom. "But how do they join the parts together so nicely? With the naked eye it seems to defy detection."

"It is said to be put together with a thin layer of Canada balsam or substance of a like nature," answered Inez. "If you hand me that bottle of alcohol, Fritz, I will show you an infallible test for a doublet. Thanks. Now you will see that when I drop the doublet into the alcohol the balsam will in

a few moments be dissolved and the parts composing the stone fall apart, leaving your ruby in a state of utter ruin."

"Oh, don't do that!" cried Fritz in sudden alarm. "Please, don't, Inez; I will take your word for it."

"Ha! ha! ha!" laughed Tom. "Oh, yes, Inez; let's have the full test."

"Why, as Fritz is willing to take my word, I can do no more than hand him back his stone," said Inez. "But as you want a test you shall have one. Take off that ring of yours, and we will try that in the same manner. I fear you will find that your emerald is also a doublet."

"Now it is my time to laugh," cried Fritz, with a burst of merriment. "Come, Tom, pass up your ring."

"Not much," answered Tom. "I am not taking chances of that particular kind. But I would like to know, Inez, how you discovered, without examination, that my ring set was a doublet."

"That is one of the secrets of the trade," laughed Inez; "but I don't mind telling you. A few minutes ago a sunbeam struck your finger, and as you turned your hand I noticed a red flash from your emerald."

"A red flash from a green emerald! But how is that possible?" asked Tom.

"It would not be if it was really an emerald. I think I can show you the red above the green. Let me have it, please. I have no doubt you have always admired your gem from the upper side. I will now turn it over so that you can see through it

from the under side with this white paper beneath it. Look, and tell me what you see."

"Why, it has a red top in good earnest," said Tom, ruefully. "I see plainly enough now. Well! like Fritz, I too have been deceived. I certainly bought this for an emerald, and paid ten dollars for it. At any rate, you can keep your alcohol bottle away; I can't afford ten-dollar experiments."

Inez enjoyed a hearty laugh at the expense of her cheated cousins. "Why, Tom," she exclaimed, "a true emerald of that size would be worth at least as much as eighty dollars. The price should have told you that it was not the stone, but yourself, that was sold. But to return to the ruby. It is a well-known fact that this gem has been increasing in price for several years. But, aside from its market value, I suppose you want to know something about the history of the stone. Among the ancient writings we find a legend that says, 'the blushing ruby was a symbol of Reuben, who brought shame upon himself by his irreverent conduct towards his father.' The finest rubies are brought from Burmah, in the East Indies, where the mines were long a royal monopoly and rigorously guarded. Just how they are handled since Burmah has become British territory, I am not able to say, but in the past the most valuable stones invariably went to the royal treasury, and the king of Burmah bore as one of his titles that of 'Lord of the Rubies.'

"Ava, the old capital of Burmah, was officially known as Ratanapura (City of Gems), and no doubt

the crown jewels were of great abundance and value. It is said that when the English dethroned King Theebaw he buried most of his jewels. In Burmah, rubies are found in a crystalline limestone, which contains bunches of blue-colored rhombohedral calcite. The royal edict commanded that all rubies discovered which had a value of over three hundred and seventy dollars should be immediately turned over to the king.

"The color of the ruby varies from the most delicate shade of bluish pink to the deepest carmine. The most valuable are of a shade called 'pigeon's blood,' which is a pure deep rich red, without any admixture of other colors. Rubies were well known to the ancient Greeks and Romans, for intaglios engraved on this stone during the highest period of Greek art, 500 B.C., are still in existence.

"Many of the ancient writers had a belief that the ruby was self-luminous, and one account, describing the court of the great Khan of Cathay, says, 'The emperor hath in his chamber, in one of the pillars of gold, a ruby and a carbuncle of half a foot long, which in the night gives so much light and shining that it is as light as day.' There is also an ancient tradition of the Brahmins which informs us that the abodes of the gods were lighted by massive rubies and emeralds.

"One noted ruby, said to be the finest of its size ever discovered, was called the 'Gnaga Boh,' or the dragon lord, and was presented by the discoverer to King Tharawadis."

"You have said nothing of the sizes of fine rubies, or the prices which they bring," interrupted Fritz.

"You should give me credit for good intentions. I have not got that far in my story yet," answered Inez. "In 1875 two extraordinarily fine rubies were brought to England, where they were recut. After cutting they weighed respectively thirty-eight and nine-sixteenths carats and thirty-two and five-sixteenths carats. The color of these stones could not be excelled. The smallest was sold for fifty thousand dollars and the largest for one hundred thousand dollars.

"The ruby is the birth-stone for July. Those who are born in July must wear a ruby, which brings to its children nobility of mind and secures a happy life. And, according to the old writer Boethius, 'the ruby is a sovereign remedy against the plague and poisons, and drives away bad spirits and dreams.' Burmah is not the only field for rubies, though the most magnificent gems are brought from there. They are also found in Siam, Ceylon, Australia, and Afghanistan, and in our own States of North Carolina and Montana."

"Are rubies imitated in any other way than as doublets?" asked Fritz.

"Yes, indeed; imitations are made in Europe by the wholesale, and so cheaply that they are sold by the gross, while true precious stones are sold by the carat."

"Well, I declare!" exclaimed Tom. "They must be cheap affairs to be sold at that rate. Can you tell us, Inez, how they are made?"

"It is no difficult matter. A mixture is made of several materials and pulverized white quartz, and these, fused together, make a substance called 'strass,' after the name of its inventor, a German chemist."

"Can you tell us what chemicals are used, and in what proportions?" asked Fritz, preparing to note them down.

"Yes; I have made a memorandum of them here," said Inez. "It is not safe to try and carry these figures in the memory." She read from the paper as follows: "'Pure white quartz, nine hundred parts; red oxide of lead, six hundred parts; carbonate of potash, four hundred and fifty parts; nitrate of potash, three hundred parts; arsenic, fifty parts; black oxide of manganese, one-half of one part.' These materials are intimately mixed, placed in a crucible and fused for twenty-four hours, and then slowly cooled. This substance (strass) is also employed in the manufacture of imitation diamonds known as French paste, and in all the colored imitations of precious stones. In making imitation rubies, eighty parts of strass, two parts oxide of manganese, and one-half part oxide of chromium are taken, these being fused together and afterwards slowly cooled in moulds of the desired shape. They are then cut and polished, ready for the market. They are harder than ordinary glass but softer than quartz. I have none of these imitations in my collection, and do not want any of them. I can assure you, however, that to the inexperienced eye they

are difficult of detection; though if a ruby were placed by the side of an imitation a child could select the ruby every time, so great is the difference when the two are compared."

They were interrupted at this moment by the entrance of Uncle Ben, who said, "Inez, you must be tired after your long talk on gems. I am sure your cousins Tom and Fritz will excuse you from a longer lesson to-day."

"Why, I was so interested and selfish," said Tom, "that I did not for a moment think of anything else. No doubt Inez is tired, and we ought to excuse her; though I must say that I could go on listening for hours without growing weary. It is all so new and fresh to me."

"We certainly have to thank you, Inez, for your interesting remarks," said Fritz; "particularly as they are so beautifully illustrated by your collection of gems. I hope you will be able to return to the subject to-morrow."

"With pleasure; unless——" Inez hesitated.

"No, Inez, not to-morrow," said Uncle Ben. "You have an engagement, if I am not mistaken. And you know that the boys have not yet seen a gold mine in operation. I was informed to-day by wire that the miners have struck a bonanza on the third level in the north winze, and must go to the mine and set the miners to stoping out the rich ore they have found. This will be an excellent opportunity to teach the boys something about mining."

"That is a bonanza for us," cried Tom, enthusi-

astically. "Count me as ready to accompany you at any time you say, Uncle Ben."

"And me, too," said Fritz. "What preparations shall we need, uncle? Will it be necessary to put on warmer clothing when we go to the mountains?"

"No, not at this time of the year. Of course, the nights are cold, but we will be in the house at night."

"Well, then," said Tom, "you can count on us both, and we thank you for the opportunity. It is just the chance I have been wishing for since we tried placer mining on Cherry Creek."

"Those are my sentiments too," said Fritz.

"Very well; we will take a night train to-morrow and reach there the next morning."

CHAPTER VII.

A VISIT TO A GOLD MINE.

THE next day was spent by Tom and Fritz in pleasant anticipation of their trip to Uncle Ben's mine, and in listening to Harry while operating with the blow-pipe in testing minerals. They had been instructed by Harry in its use, and had made fair headway. During the day, Chester Ecker, a boy about fourteen years of age, called, and begged to be made one of the party to the mine. Chester was one of the brightest little fellows in Denver, and a firm friend of Harry's. He had recently purchased a small photographic camera, and promised to take it with him and get some mountain views. Uncle Ben told him to get ready and meet the party at the train that night.

At ten thirty P.M. the train left Denver. The journey took most of the remainder of the night, the party arriving at the mountain station at half-past five the following morning. At the station they found a conveyance waiting to take them to the mine, six miles away. Here they enjoyed a hearty breakfast in the miners' boarding-house, and were then ready to enter the mine, which was situated on the opposite side of the ravine from the boarding-house.

Through the ravine ran a clear stream of mountain water, dashing and spraying over the moss-covered rocks in thousands of miniature cataracts. The summit of the mountain range was a little more than a mile away, and from it an extended view of the surrounding country could be had. After breakfast, the foreman of the mine told Uncle Ben all about the rich streak of gold which had been found, and, leading the way to the assay office, he unlocked a drawer and brought out about thirty pounds of what the boys were told was the mineral called sylvanite, or telluride of gold, a valuable ore.

Uncle Ben looked at it with more excitement than he usually showed, and anxiously inquired if it had been assayed. His feeling of pleasurable excitement evidently increased when the foreman informed him that it averaged thirty-four thousand six hundred dollars per ton in gold, a promise of increased wealth which certainly warranted some show of feeling.

All being in readiness for the descent, Uncle Ben and the foreman were lowered down the incline shaft in a car, getting off at the third level, where they waited while the car ascended to the surface and returned with Harry, Fritz, Tom, and Chester. The foreman supplied each of them with a lighted candle, and they followed along the level for a distance of one hundred and forty feet to the north winze, stopping frequently along the route while Uncle Ben pointed out the hanging wall and the foot wall that enclosed the mineral-bearing vein.

He would occasionally stop and pick out some of the rich ore, and show the boys the glittering gold by candle-light.

When the winze was reached, they found a miner hoisting a bucket of ore by the aid of a rude windlass, and heard the "huh! huh! huh!" of the miner below, who was striking with his hammer on the head of a steel drill, while another miner held the drill, turning it after each stroke. As soon as the ore was taken out, the bucket was lowered a short distance in the winze. Uncle Ben grasped the rope, and, with one foot in the bucket, said, "All right." He was at once lowered to the bottom, while the boys stood by in open-mouthed astonishment at his agility and fearlessness. Harry assured them that there was no danger, as the rope was strong and new, and that it was only forty feet to the bottom. Having examined the new find of rich ore, Uncle Ben returned on the bucket, Harry assisting the man at the windlass.

After some persuasion, Fritz went down in the bucket with Harry, who returned and again went down with Tom, Chester preferring to remain above until their return.

Harry now took the opportunity to explain to his cousins all the different workings, showing them the vein of white quartz, which was clearly defined between the granite walls, and then pointing out the vein of high-grade telluride of gold which ran through the centre of the larger vein. This vein of rich ore was only two inches in width, while the

mineral vein proper was four feet wide. Tom and Fritz, at Harry's suggestion, knocked off what specimens they wanted, after which they ascended to the third level, and the party proceeded along the level to the incline. The bell-cord being pulled, the engineer lowered the car down to the station. When they were all in the car Harry again rang the bell, and a quick ascent to the surface was made.

The remainder of the forenoon was spent in watching Uncle Ben, who was engaged in making assays of samples of ore taken from the mine. As a description of the method pursued by him may perhaps be interesting to the reader, we give it in general terms.

The ore is first pulverized in an iron mortar and then sifted, the sieve used being what is termed number sixty,—that is, it contains sixty holes to the linear inch, or three thousand six hundred holes to the square inch. After passing through the sieve, the substance is mixed by means of a spatula, and spread out thinly on a paper. Some of it is then taken up on the point of a knife, a little here and there, and placed in the balances or pulp-scales until there is sufficient for what is known among assayers as the ton-weight (which will be explained hereafter).

The weighed ore is next placed in a scorifier (a small clay dish), and mixed with five or six times its weight of granulated lead, after which a small quantity of borax glass is placed on top of the mixture. The assay is now ready for the furnace, or,

rather, for the muffle in the furnace, and is exposed to a strong heat for a few minutes, or until the contents of the scorifier have become a molten mass.

The door of the muffle is now opened to admit oxygen. In half an hour the contents are ready to be poured into cone-shaped iron moulds. In these the substance soon cools, and is then thrown out and the slag hammered away from the metal. A cupel is now put into the muffle, and when this is red-hot the metal is put into it and the muffle-door closed for a few minutes, or until the metal in the cupel is melted, after which the muffle-door is opened to admit the air. As rapidly as the lead is oxidized it is absorbed by the bone-ash cupel, and the metal button becomes smaller and smaller, until finally the lead has entirely disappeared, and only a button of pure gold or silver remains.

If the ore, as was the case in Uncle Ben's mine, yields both gold and silver, the button is an alloy of each. To separate the gold from the silver, the button is wrapped in silver and lead, the exact weight of the silver employed being noted. The assay is again put into the cupel, and the process described is repeated until nothing remains but the button of gold and silver. This button, we will say, weighs one hundred and twenty-one milligrammes, ninety milligrammes of which we know to be the pure silver which the assayer added to the original assay to facilitate the parting or separation of the gold and silver. Subtracting this from the total weight, there are left thirty-one milligrammes that must have

come from the pulverized ore. The large button is now placed in a glass tube which contains nitric acid, and is held over the flame of an alcohol lamp. In a few minutes the silver is dissolved by the acid, and the gold falls to the bottom of the tube as a black powder.

The tube is now carefully decanted and the liquid poured out, great care being taken that none of the black powder goes over. The tube is next filled with water to wash out any remaining silver solution, and is a second time carefully emptied. The tube being once more filled with water, a small fire-clay cup (known as an annealing cup) is placed in an inverted position on top of it, and by a quick turn of tube and cup the tube is inverted and the gold falls through the water to the bottom of the cup. By slowly raising the tube, its mouth is brought to the outer edge of the cup. A quick movement outward takes the tube and its contents away, the gold remaining in the cup. The water in the cup is now poured off, and with its gold contents is placed in the muffle, where a cherry-red heat soon drives away the black film on the gold and causes it to assume its natural color. It is now chemically pure gold and is weighed as such.

It will be remembered that we had thirty-one milligrammes of metal from the ore before the parting by acid; the gold that remains in the cup only weighs twenty-two milligrammes, a fact which shows that nine milligrammes of silver have been taken out by the acid. Before proceeding farther,

it will be necessary to explain the ton-weight used by assayers. In a ton of two thousand pounds there are twenty-nine thousand one hundred and sixty-six ounces. The ton-weight of the assayer contains the same number of milligrammes. It will therefore be readily understood that if the assayer took ore weighing twenty-nine thousand one hundred and sixty-six milligrammes, and obtained a button of metal weighing one milligramme, then the ton of two thousand pounds would yield one ounce of gold or silver.

Now to continue our assay. It will be remembered that the gold from the dry cup weighed twenty-two milligrammes, which indicates that the ore or pulverized rock held twenty-two ounces of gold per ton. Before parting the gold and silver by acid the button weighed thirty-one milligrammes, the difference (nine milligrammes), which was dissolved out by the acid, being the silver contained in the rock, which, therefore, yields nine ounces of silver per ton.

Let us now figure out the total value per ton. Gold is worth twenty dollars sixty-seven cents, and eighteen one-hundredths of a cent per ounce, which, multiplied by twenty-two (the number of ounces per ton), gives us four hundred and fifty-four dollars, seventy-seven cents, and ninety-six one-hundredths of a cent in gold. To this must be added the value of the nine ounces of silver. Silver is quoted to-day at sixty-four cents per ounce, making the nine ounces of silver worth five dollars and seventy-six cents, which, added to the value obtained in gold,

gives us a total value contained in a ton of ore of four hundred and sixty dollars fifty-three cents and ninety-six one-hundredths of a cent.

Tom and Fritz watched the operation closely, making notes in their books for future reference. After Uncle Ben had weighed the assay buttons, Tom asked him how close the assay scales would weigh, or rather how small an object; as he had noticed what a very small thing a milligramme was. He was greatly astonished when Uncle Ben informed him that he could weigh the tip end of a fly's wing. Tom caught a fly, and, cutting off the outer half of a wing, asked Uncle Ben to weigh it. Uncle Ben placed it on the scales, and told Tom that it weighed exactly the one-twentieth of a milligramme, and advised him to hunt up something lighter. But Tom's curiosity was satisfied, he acknowledging that he really believed that Uncle Ben could weigh a sunbeam.

"But why did you put those ninety milligrammes of pure silver in the assay?" asked Fritz.

"It was necessary to obtain the chemical action," said Uncle Ben. "The nitric acid would not affect an alloy of gold and silver unless there were three times as much silver as there is gold. When that proportion of silver is present the acid will dissolve the silver, and the gold, which is not soluble in nitric acid, will fall as a black powder. The operation is known as quartation."

"Well, that is certainly interesting. By the way, something was said, I think, about borax glass. Now, what is borax glass?"

"It is borax that has been melted. You have perhaps noticed that borax, when heated, puffs up. When melted it fuses to a clear glass, which is called borax glass, and is used by assayers after being pulverized. If borax in its natural form were used it might puff up and roll out of the scorifier, carrying with it some of the pulverized ore, and thereby cause an incorrect assay."

"I had it in mind to ask the same question," said Tom. "But I must confine my curiosity now to granulated lead, such as you used for assaying. How is this prepared?"

"It is an easy process. Bars of lead, which must contain no silver or other metal, are melted in a crucible and poured into a hollowed-out wooden dish. The chopping-bowl, a common kitchen utensil, will answer the purpose. It must be kept level while a man at each end shakes it back and forth until the lead is cold. Usually, three-fourths of it will then pass through a common flour-sieve, the lead having assumed the appearance of coarse blasting powder."

"I understand that what you call a level in a mine means the workings where you branch off from the main tunnel, incline, or well," remarked Fritz. "That is, where you cut horizontally into the rock from any chosen point."

"Don't say a well," answered Uncle Ben. "Its proper name is a shaft. A well is a hole in the ground dug for water; a shaft is one dug for mineral. You are right, however: the first working to branch

off is called the first level; the second, the second level, and so on."

"If you call a hole in the ground a shaft," rejoined Fritz, "why did you call that hole we went into this morning a winze?"

"A shaft is a hole in the ground beginning at the surface," was the reply. "A winze, on the contrary, is a hole in the ground starting from a working beneath the surface and passing downward, it being usually made for the purpose of connecting one level with another."

"Stop asking questions for awhile and listen to me, Fritz," said Tom. "Harry and Chester are waiting for you and me to accompany them to the summit of the mountains. Are you ready to go? Will you go up with us, Uncle Ben?"

"I think not. I have been up there often; and, besides, I shall be busy until evening making assays. Tell Chester to take his camera. He may be able to procure some beautiful views on the trip."

Two horses and a light wagon driven by Harry soon conveyed the young men to the summit of the mountain, where a view could be had in a westerly direction for a distance of forty miles. Tom and Fritz gazed long at the scene, filled with wonder and admiration. It was their first view of the backbone of the continent,—the summit of the Rocky Mountains.

"See here, boys," exclaimed Chester. "Over there to the right, I mean. Do you see that mountain that looks as if it had a white cross on it? I'm going to take a snap shot at that."

"Hold on!" cried Tom. "Wait a moment till Fritz and I can put our handsome forms in the foreground. It will add a double charm to your picture."

"No, you don't," declared Chester. "The mountain of the cross is too holy a subject to be thrown into the shadow by two such sinners as you and Fritz."

While Chester was busy taking the photograph, the others wandered on for a few rods, Fritz and Tom seating themselves on the rocks, while Harry described the surroundings.

"The mountain that Chester just now pointed out and is taking in his snap shot," he said, "is called the Mountain of the Holy Cross. The cross is made of perpetual snow, its long lobe being a deep cañon into which the sun never shines. The cross part is a gold-bearing quartz vein largely impregnated with iron pyrites, which the elements have oxidized and washed out. The result has been a deep cut along the mountain side, which is also filled with snow and is out of the reach of the sun. The quartz vein was once located for a gold mine by an old friend of my father, a prospector whom the miners called Frenchy La Fave. The mountain was named centuries ago by Coronado, a Spanish general, who first discovered it from Argentine Pass, where he halted his command and where the priests said mass. That was in the old days, shortly after Cortez conquered Mexico."

"Is that a town lying off there to the left?" asked Fritz. "And off there to the right there seems to be another."

"They are towns, no doubt. The one to the left is the town of Breckenridge, a place noted for its many rich mines of gold. The other is Dillon, and the stream of water which you see passing through the town is named Ten Mile River. Notice now the huge dome-shaped mountain just behind Dillon. That is Mount Buffalo; and the high peak west of Breckenridge is called Quandary Mountain. It is one of the highest in the State. East of Breckenridge lies another, which has been given the familiar name of 'Old Baldy,' from the fact that no timber grows upon its top."

"What is the reason that timber does not grow on it?" asked Tom.

"It grows thick enough, no doubt, lower down," explained Harry; "but all parts of it that can be generally seen from this locality are above timber line, being about eleven thousand feet above the ocean-level. At that altitude timber does not grow except in rare instances."

"Then I judge we must be above timber line here," said Fritz, "for the rocks are bare of vegetation all around us."

"Indeed we are. In fact, we now stand fully fifteen hundred feet higher than timber line, we being about twelve thousand five hundred feet, or nearly two and a half miles, above sea-level."

"I wonder if Tom and Fritz will ever again get this near to heaven?" said Chester, who had now joined them.

"That's a good one, Chester," cried Tom. "I

propose to write a letter from this very spot to my father, and locate it twelve thousand five hundred feet nearer to heaven than he has ever been. How did you succeed with your picture, Chester?"

"I'm afraid it will not be a good one, as the view was in the west, while the sun was also pretty well westward. To take a picture successfully, one needs to have the sun at his back."

"The sun is pretty well down, that's a fact," said Harry. "We must hurry to get back to the mine before dark, even if Tom does not get his high-level letter written."

"Anyhow, I have got the date and place down on my paper," said Tom. "I can finish it a little farther away from heaven."

Uncle Ben was waiting for the boys when they arrived, and escorted them in to supper, which they ate with a relish, Fritz declaring that it was the best coffee and the sweetest bacon he had ever tasted. On the following morning the party was conveyed to the railroad station, halting once on the way long enough to allow Chester to take a photograph of a group of silver-tipped fir-trees. The train arrived at Denver in the early evening, where a carriage was in waiting to convey them to the palatial residence of Mr. White on Capitol Hill.

CHAPTER VIII.

A CHAT ON SILVER AND DIAMONDS.

THE morning after their return from Uncle Ben's mine, Harry told the boys that his father desired to rest, and had requested him to tell them something about silver, which he was quite ready to do if they cared for a lesson on the white metal. As they protested that nothing would please them better, he began.

"No doubt you think you know what silver is," he said; "yet, I venture to say, neither of you has ever seen a piece of pure silver."

"Indeed, my dear fellow, you are making a big mistake there," said Tom. "You forget that uncle showed us a ribbon of chemically pure silver the other day, which he used in assaying."

"So he did; I had forgotten that. But there are plenty of things you ought to have seen, and haven't; so one lack will answer for another. As for the United States silver coins with which you are familiar, they are alloyed with ten per cent. of pure copper. Here is a small ingot of pure silver. It is, as you see, a bright white metal, which has always been valued for its beauty, lustre, and rarity. In some lights it has a slightly red tinge. Like gold, it can be hammered into thin leaves and

drawn into a fine wire. It fuses at about eighteen hundred degrees Fahrenheit. It is used by all civilized nations for coinage, and is then always more or less alloyed with copper to give it hardness. It is extensively employed in the manufacture of plate for royalty and persons of wealth.

"The English royal plate at Windsor Castle is estimated to be worth ten millions of dollars. There are two state dinner services, one of gold and the other of silver, of which that of gold was made during the reign of George IV., and will dine one hundred and twenty persons. On state occasions there is always placed on the table some very beautiful gold flagons which were captured from the Spanish Armada, and are of almost priceless value. In a corner of the apartment, during these state banquets, can be seen the great silver wine-cooler, weighing seven thousand ounces. The silver dinner-service of Mrs. J. W. Mackay, wife of the California Bonanza king, is valued at one hundred and ninety thousand dollars. Her husband presented her with the silver of which it was made, it having been taken from his mines in the State of Nevada. This is said to be the most costly silver set in the world.

"Silver is largely used in the arts, and it is estimated that at least one million ounces of it are totally dissipated every year in the art of photography. Native silver is sometimes found in the mines; but it is rare, the mines generally yielding silver in the form of sulphide or chloride. The principal ore of silver is the sulphide."

"If you will let me take you back a step, Harry," said Fritz, "I should like to know why you speak of John W. Mackay as the 'Bonanza king.' I have often seen the word 'bonanza' in print, but don't understand it. Won't you please explain what it means?"

"It is a Spanish word," answered Harry, "its various meanings being 'prosperity,' 'to succeed,' 'to go on prosperously,' 'to do well.' When there is a large body of rich ore exposed in a mine, it is then said by the Spanish and Mexican miners to be 'in bonanza,' since the mine then promises a prosperous yield. When there is no pay ore in sight, it is said to be 'in borra,' which, as you may guess, has the opposite meaning. Mr. Mackay was dubbed the 'Bonanza king' while acting as manager of the consolidated Virginia-California mines in the State of Nevada. He and his partners, who were all poor men, pushed ahead with vigor and energy from the surface down to a depth of eleven hundred feet before finding any ore that would pay to work profitably. At that depth what is known as the 'great bonzana' was discovered, and upwards of sixty millions of dollars were paid out as dividends in a short time."

"And how do they find whether a certain rock contains silver or not?" asked Tom; "that is, what would be a simple test for silver in the vein?"

"There is one that would fit most cases, but not all," answered Harry. "The method is to pulverize the ore and place a small quantity in a test-tube;

then enough nitric acid is poured into the tube to supersaturate the ore. Afterwards the glass tube is held in the flame of an alcohol lamp, and its contents allowed to boil till the brown fumes cease issuing from the tube. This done, we fill the tube with water and allow the sand to settle for about twenty minutes, after which we carefully pour the liquid into another clean glass tube, allowing none of the sediment to pass over. We now drop a few grains of salt into this second tube. If there is a small quantity of silver present the solution becomes cloudy; but if the ore contains a large amount of silver it will be precipitated, chloride of silver being formed from the chlorine in the salt and falling to the bottom of the tube, since it is insoluble in water. The ore may possibly contain lead, which, like the silver, is dissolved by the acid, and also precipitated as a chloride. We therefore take advantage of the fact that chloride of lead is soluble in water, while chloride of silver is not, and add to the solution sufficient water to dissolve the former. The liquid, which now contains the lead in solution, is poured off, and the silver chloride placed on charcoal and reduced to the metallic state with a blow-pipe."

"You said that the test you have just described would not always answer the purpose. Why not?" asked Tom.

"Because, if the ore contained chloride of silver, the nitric acid would have no effect upon it, since the chloride is not soluble in any acid. When the

ore, therefore, contains chloride of silver, strong ammonia or a solution of hyposulphite of soda is used to dissolve it. If nitric acid be then added, the chloride of silver will drop to the bottom of the tube as before. It is a good plan in making these tests for silver to roast the rock well in a hot fire, since the heat will change the sulphide and chloride to metallic silver, and it is then quickly acted upon by the acid. Silver is precipitated from an acid solution by placing a copper plate in it.

"Large masses of native silver are occasionally found, and there is a huge specimen in the museum of Denmark which weighs more than six hundred pounds. But the metal is generally found associated with other minerals, mostly with lead, copper, antimony, arsenic, and sulphur. In early times gold and silver approached each other nearer in value than at present. An ounce of gold was worth from ten to twelve ounces of silver, the variation depending upon the accidental relation of the supply of both metals. After the discovery of America, the quantity of silver found in Mexico and Peru was so great compared with that of gold that silver became cheaper, so that an ounce of gold was equal to fifteen ounces of silver. Still later discoveries have made it so much cheaper that to-day it takes thirty-six ounces of silver to buy one of gold."

"When was silver first discovered?" asked Fritz.

"Oh, come now, you are asking me much too hard a question," said Harry. "It goes back far towards the beginning of things. The oldest his-

tory, and even the ancient legends, speak of the use of silver. I think I had better confine myself to its discovery in this country. In the State of Nevada it was first discovered by a miner named Comstock, who at that time was mining for gold. Having found some heavy black material in his sluices, he sent it to San Francisco for analysis, and the chemist there pronounced it to be sulphide of silver. This announcement caused a great excitement, and in the following year the mountains of Nevada were covered with miners prospecting for silver. I need not say that they were highly successful, and that these mountains have added largely to the world's stock of the white metal."

"Was this the first discovery in America?" asked Tom.

"Oh, by no means. Silver has been mined for centuries in Mexico and Peru. The silver mines of Peru were first discovered by an Indian shepherd, who, being cold and tired, had built a large fire on the hillside and laid down for the night. In the morning he was surprised to see the rock against which he had made the fire covered with shining silver. The shepherd informed his master, who with a little labor developed a rich vein of silver. The mine was named 'the discovery,' and, although first found nearly three hundred years ago, is still producing silver.

"As an instance of the richness of the Peruvian silver mines, it is said that upon the occasion of the christening of a child of a rich mine owner the

vice-queen, who had consented to become the god-mother, walked from the house to the church on a pavement made of a double row of bars of silver, placed there by the father of the child. After the ceremony the pavement was presented to the vice-queen, in gratitude for the honor conferred.

"Many of the shafts in silver mines are so deep that mining is unprofitable. On the Comstock lode in Nevada several of the mining shafts have reached a depth of more than three thousand feet, and the walls of the vein are so hot that a burning sensation is felt if the hands are placed on them. The mining is done by two shifts of men, who wear only shoes and pants. One of the shifts will enter the hot workings and stay there from ten to fifteen minutes. By that time the heat has grown unbearable, and the men retire to the ice room, while the other shift goes to the front. Of course, this makes the work very slow and costly, though the result pays for the cost of the labor. I must say, however, that, though Nevada has been the great silver-yielding State of our country, this is not the case to-day. Other States have come up and Nevada has fallen off. Colorado is now the richest silver State, and Montana comes next, while Utah, Idaho, and Arizona surpass Nevada, which now yields but one-fortieth part of the whole United States product."

"Three thousand feet isn't any trifling depth to go down," said Fritz. "And, by the way, what is the depth of the deepest hole in the earth at the present time? How far away have these delvers

and diggers got from the upper air and the clear sunshine?"

"I fancy you think I am a walking encyclopædia," said Harry. "But I can answer that question, for I read it up only yesterday. The deepest hole is one at Poroschowitz, in Upper Silesia. It is a bore-hole through solid rock, and is six thousand seven hundred feet in depth. Work still progresses, and it is expected to reach a still further depth of one thousand six hundred and seventy feet. It will probably develop some very interesting facts on temperature, but it is not large enough for any of your delvers and diggers to go down. If they should try it, I calculate they would have a tight squeeze and find themselves in a hot-box. You found it rather cold when we got twelve thousand feet above sea-level. But going down you would find the heat to increase at a faster rate still, and I fear would soon feel the blood boiling in your veins."

"Ugh! you make my flesh shrivel at the thought," declared Fritz. "I don't propose to go down to that depth, either now or hereafter; not if I have any say in the matter."

"I hope not; if you do, don't ask for my company," said Harry. "But that is all I have time to say on silver. Inez proposes to take you in hand this afternoon and tell you something about diamonds. I have it in view, if you care for it, to teach you how to test the various metals with a blowpipe, but will have to leave that until to-morrow."

"Many thanks, Harry," said Tom. "I have been waiting for that talk on the blow-pipe. It seems to me a mystery how you reach your results so quickly."

"And to me, too," said Fritz. "I have seen Harry and Uncle Ben take a small fragment of rock or metal and in a few minutes be able to tell what it contained. What hocus-pocus they used I can't guess, but we will kindly permit Harry to tell us."

"Much obliged for your kindness," said Harry, with a laugh; "though I fancy that you are fitting the boot on the wrong foot."

After dinner the boys found Inez in the library waiting for them, with her casket of gems open for their inspection.

"We should have been here sooner, Cousin Inez," said Tom, "and must beg your pardon for not being more prompt. The fact is, Eva detained us, showing some of the sketches which she made in Mexico."

"I hope you enjoyed them. Harry and I can't expect you to give all your time to stones, even if they are precious ones like mine. Eva was saying this morning that it is getting to be much too one-sided."

"What queer-looking affairs those Mexican houses are," said Fritz. "Eva says they are built of sun-dried bricks called 'adobe' (a-do'be). The sketches taken on the road from Vera Cruz are simply grand."

"Did she show you her sketch of a water-carrier?" asked Inez.

"Yes; he was loaded down with two immense

jugs of water, one in front and the other behind, and both hanging from the head by leather straps. They looked heavy enough for a mule to carry, much less a man. There was another sketch of a half-naked woman carrying a naked baby. I should judge from that drawing that it must be very warm in Mexico."

"Why, yes, it is not Arctic temperature," answered Inez; "particularly in the city of Vera Cruz, where those sketches were made. We were there in the month of November, and the weather was what you may well call tropical. You could almost have roasted potatoes on the stone walls. At any rate, we were not many degrees below roasting. But Harry says he promised you, at my expense, a talk on diamonds."

"Just so," rejoined Tom, "and my mouth has been watering every since. You don't know how anxiously I am waiting to hear what you have to say about those glittering gems."

"Come, now, if you are going to make sport——"

"Not a bit of it," interrupted Tom; "I am in solid earnest,—solid as a diamond itself."

"By the way, Inez," said Fritz, "what is this yellow beauty?"

"That is amber," said Inez. "It is not a precious stone, but it is much in demand as an ornament in Turkey and Spain, where it is mostly worn by ladies of the brunette type. I remember reading a short time since an account of a visit made by an English lady to a Turkish harem. This is what she said, as

near as I can recall, about the amber ornaments worn by a beauty of the seraglio.

"'In her hair she wore a golden comb, in which were set three pieces of translucent amber, the centre piece being as large as a pigeon's egg. Around her neck was worn a necklace of gems made from amber, each piece averaging about the size of a hazel-nut, and all faceted. They were bright yellow, and resembled Brazilian topaz. Around the waist she wore a girdle which hung down from the left side to the ground, all composed of amber pieces set in gold. She had an olive complexion, her arms were bare to the shoulders, her hair was as dark as night, and, with laughing black eyes, she looked ravishingly beautiful decked in her attractive amber ornaments.'"

"She must have been a beauty, even without the amber," said Tom. "I should like to visit Turkey."

"And to see some of the beauties of the harem, I suppose?" queried Fritz.

"Oh, yes; I should have to take that in among the sights."

"Your life would be forfeited if you were found within the harem walls," said Inez. "The Turks guard their beauties very jealously. But to return to the subject of amber, it is, as I have said, not a precious stone, but a fossil gum from trees which are now extinct, and is in structure hard, brittle, and translucent, or at times fully transparent. If you examine this specimen closely, you will see within it a perfectly preserved insect. This poor

unfortunate was caught while the gum was thin, and has ever since dwelt within its yellow prison walls. Many ancient insects are thus preserved in amber coffins or prison-houses. When amber is rubbed or heated it gives off a peculiar, agreeable, aromatic odor, and manifests electric attraction. In fact, our word electricity is derived from the Greek name for amber, 'electron.'

"Amber is found principally on the Baltic coast, between the cities of Königsberg and Memel, in blue sandstone. It occurs abundantly under water, and large specimens of it are occasionally thrown up after storms. Amber fishing is there an important industry. In Paris the most beautiful wares are made of amber, for which extraordinary prices are obtained. Turkish smokers use it as a tip for their pipe-stems, and the Turk believes that it will prevent him from inhaling pestilence. I need not say that the smokers of our own country also indulge in amber mouth-pieces."

"Is it all yellow, like this piece?" asked Tom.

"It is said to be found of various colors, but mostly yellow or orange."

"Have you any of other colors?"

"No; this is my only specimen. Amber is no new thing, for mention of it is found in heathen mythology. The Greeks have a tradition concerning its origin, to the effect that it arose from the tears of the sisters of Phaeton, who, as a punishment for lamenting his death, were turned into poplar-trees, which poured forth their perpetual tears into the

river Eridanus, the tears being congealed into amber. 'Amber tears from dead trees,' to use a poetical phrase for this substance, are supposed to have medical properties, it being said that 'A string of amber beads worn around the neck is a charm against affections of the throat, and insures the woman who wears it good luck and a long enjoyment of the qualities that make her attractive.' It is sometimes found in large masses, a specimen in the royal museum at Berlin weighing eighteen pounds."

"Is it not found in the United States?" queried Tom.

"Yes," was the answer; "it is found in New Jersey, Maryland, and Washington. In the latter State it has been discovered on the Sulton River, where it occurs in thin seams in a gray sandstone. But there, I declare if we have not wasted most of the afternoon and have said nothing yet about diamonds. Somehow we drifted into this side issue about amber."

"I should not object to your drifting into other attractive side-paths," said Fritz. "If you only knew, Inez, how much I have enjoyed all you have said about amber, you would not think the time wasted."

"Not if I have any voice in the matter," declared Tom. "I found it very interesting and instructive. For that matter, our time is passing so pleasantly and so profitably that I dread to think of the termination of our vacation. It just suits me to go to school in this fashion, and I do not know where I could get such a variety of facts in so short a time."

"Thank you for your compliments," said Inez. "I have never posed as a teacher before, and am glad to find my poor efforts so well appreciated. Speaking of diamonds, it is a well-known fact that they are pure carbon. Charcoal also is composed of carbon, but not crystallized, as in the diamond. Carbon in the form of diamond is the hardest known substance, but as charcoal it is one of the softest. Carbon, as you probably know, is very abundant in nature as a gas, being combined with oxygen to form carbonic acid gas. There are many theories as to how it has taken on the solid form of the diamond. The theory of Professor Simler of Breslau is the one most generally accepted, this being, that it is the result of the crystallization of carbon from a liquid solution. He holds that carbonic acid became collected in cavities, where under great pressure it assumed the liquid state, and then dissolved some previous form of carbon. The carbonic acid gradually made its way out through fissures, while the dissolved carbon slowly crystallized into the diamond. This theory would explain the presence of a small yellow diamond in a large white rough diamond now on exhibition in the British Museum, which seems to show plainly that it had been forced into the larger diamond while in a liquid state."

"I have heard of artificial diamonds being made," said Tom. "How does the way of making them agree with this theory?"

"Very well, I should say," answered Inez; "though, of course, I do not set up as a competent

judge. I shall tell you later what I know of the methods of making, not artificial diamonds, but real diamonds made artificially."

"But before going into that, can you let me know where diamonds are found?" asked Fritz. "I want to know, in case I should suddenly take a notion to go diamond hunting."

"You could have your choice of places," said Inez; "though I am afraid you would find the best places everywhere taken up. Diamonds are found in Brazil, Borneo, India, Australia, Sumatra, South Africa, British Guiana, Russia, and a few in the United States."

"The United States is the nearest locality," said Fritz. "I think I shall begin there."

"And the poorest," answered Inez, "unless you begin in the jewellers' stores, where you will find a fine outcrop, though one that is rather expensive to work."

This sally set the boys laughing, in the midst of which a servant announced a caller to see Miss Inez.

"There! I knew we would be interrupted," said Inez, pursing up her pretty lips. "I suppose there is no help for it; but, if you do not mind, we will go on with the diamond after supper."

"That suits exactly," said Fritz. "Meanwhile, I will go out and prospect in the Denver-shop diamond mines."

"And I will keep you company," said Tom.

CHAPTER IX.

THE QUEEN OF PRECIOUS STONES.

WHEN the party assembled in the evening, Fritz and Tom were much surprised at meeting Jessie and Estelle Elliott, who declared that they had called to spend the evening with Eva and Inez. Inez informed them of her promise to the boys, and they insisted that she should go on with her lesson, saying that they were quite as much interested in diamonds as any boy in Denver.

"I love to look at diamonds," declared Estelle, "and carry my love to the extent of reading or hearing about them. The diamond is the stone for my month, as I was born in April."

"On the first?" asked Jessie, with a roguish twinkle in her eyes.

"No; on the twenty-second, as you know very well; so you can't get off that old joke on me. The diamond is my birth-stone, and whenever I receive a present from papa it is sure to be a diamond."

"Why wasn't it I that was born in that sparkling month?" asked Jessie. "You have had all the luck. I was born in December, on the last day of the month, and, of course, the last day of the year. Papa says it was also the last day of the week, the

last hour of the day, the last minute of the hour, and the last second of the minute; and that I was very fortunate to have been born that year at all."

"Then if you had been born two seconds later you would have been a year younger," said Fritz.

"I don't see that," said Jessie.

"Why, if your birthday is now 1840, then it would be 1841."

"You wicked sinner! Would you make a grandmother of me?" cried Jessie, shaking her clustering locks at him. "1840, indeed! You will be saying next that it was a piece of bad luck that I was born at all."

"A piece of good luck, I should call it," said Tom, with a look of admiration in his eyes. "I think I know some people that could be better spared."

"You don't mean me?" cried Fritz.

"Present company always excepted," said Jessie. "But haven't I some birth-stone, Inez, even if I have lost the diamond?"

"Yes, and a very pretty one, too. The birthstone for December is the beautiful blue turquoise. If you had been born two seconds later, your birthstone would have been the garnet, which belongs to January. Whether you were lucky or not depends on which of these you prefer. But to return to our subject: in the olden time many virtues were attributed to the diamond. It was believed to protect the possessor from pestilence, poison, or enchantments of any kind. Warriors had the

image of Mars engraved upon diamonds, as it was then believed to insure success in battle to its fortunate possessor."

"How did they do that?" asked Tom. "You have told us that there is no other stone hard enough to cut the diamond."

"I suppose it was on the principle of 'diamond cut diamond,'" said Inez. "The diamond may be ground down with the aid of diamond dust, and probably some such means was used. The old nations were experts in gem-cutting, and we know very little about how they did it."

"'Diamond cut diamond' has got to be a convenient proverb," said Fritz, "to indicate when one sharp fellow gets the best of another."

"I of you, for instance," said Tom, demurely.

Tom's expression, which indicated anything but sharpness, set them all laughing. When they had subsided to gravity again, Inez resumed her description.

"India supplied the world with diamonds," she said, "until their discovery in Brazil in the early part of the eighteenth century. Brazil then took the lead, and held it until the discovery of diamonds in South Africa in 1867. They were first mined for in Africa along the Vaal River as far as the Orange River, and along this to Hopetown. These diggings yielded abundantly, and have produced many fine stones, two of which have a world-wide celebrity. These are known as the 'Star of the South' and the 'Stewart.' In these river diggings, or placers as I

may call them, the stones were washed out by water and deposited along the streams. They were in great measure abandoned in 1871, on the discovery of the Kimberley and other mines, which, in contradistinction to the river diggings, are known as the 'dry diggings,' and yield us the stones in their native habitat, deposited in a peculiar hard earth, in which they are found to a depth of several hundred feet. Since the original discovery of diamonds in South Africa in 1867, more than forty million carats have been produced, of a value of more than four hundred and fifty millions of dollars."

"Why, I should think such mines as those would supply the world for many years to come," said Jessie.

"The quantity has been very great, it is true," said Inez, "but the quality has often been very inferior. Probably not a tenth part of these stones have been suitable for gems. Many are off-color, yellow and black. Of these, the black are only used for polishing other diamonds, and for boring with the diamond drill. It is a curious fact, that the black diamonds of the variety known as 'carbonado' are harder than the light-colored variety."

"That certainly is curious," said Fritz. "I wonder if there is something in the black coloring matter that makes them hard. But you spoke of the diamond drill. How does it work? I know that it is used for rock boring, but I have often wondered how the diamonds could be kept in place."

"There seems to be no difficulty in this," said

Inez. "Small holes are made in the end of a heavy iron pipe, into which the diamonds are fitted and firmly set with cement. The diamond end of the pipe is now placed against the rock, and by the aid of steam, compressed air, or electricity it is made to revolve with great rapidity, as fast as from fifteen hundred to two thousand times per minute. It will bore a hole in the hardest granite at the rate of from three to five inches per minute. As the drill penetrates the rock, the iron and diamonds are kept cool by a stream of cold water. The diamonds, you understand, cut out a circle in the rock, and a core of solid stone enters the pipe. When the cutting has proceeded to the depth of one length of pipe, it is lifted to the surface and the core extracted, leaving a hole of the full diameter of the pipe. Another ten feet section of pipe is then attached and the drill again dropped into the bore-hole, when the operation goes on as before. In that way, by adding length after length, a hole of great depth can be made."

"Do all diamond mines furnish the hard substance you spoke of, the carbonado?" asked Fritz.

"No; this is only found in the mines of Brazil. The mines of India and South Africa produce black diamonds which are crystalline in structure, and are known by the name of 'bort.' The carbonado of Brazil is granular and harder."

"I don't care much for your black diamonds, even if they are good as borers," said Jessie. "I prefer not to be bored. But just what is meant by off-colored diamonds?"

"That is a term generally applied to diamonds of a yellow color. The yellow tinge greatly decreases their value, as you know?"

"But what is the cause of this yellow color?" asked Estelle.

"It is thought to be due to the presence of other minerals, principally iron pyrites. At the Kimberley mines of South Africa large quantities of pyrites exist in the diamond-bearing earth, and a large proportion of the diamonds obtained there are of a yellow color, so that the two facts seem connected. At Jagersfontein, on the contrary, there are no pyrites, and the diamonds are nearly all pure white, a yellow stone being a rarity. By putting 'that and that together' it would seem as if the pyrites caused the trouble. The celebrated 'Stewart' diamond, which weighed in the rough nearly two ounces, is of a light yellowish color, but is extremely brilliant. Its color, however, detracts considerably from its value. One of the largest diamonds found in the Kimberley mines is octagonal in shape, and measures around the girdle almost as much as an ordinary sized hen's egg. Its weight in the rough state was four hundred and twenty-eight and a half carats. But this is far surpassed by the 'Excelsior,' a diamond found a few years ago, and said to weigh nine hundred and seventy-one carats. So far as mere size is concerned, it is the giant among diamonds."

"What is a carat?" asked Jessie. "All I know is that it has no relation to carrot, though they sound very much alike."

"But a different letter in a word may give a mighty difference in meaning," said Tom.

"The word carat," answered Inez, "is derived from the name of a bean, the product of a tree called 'kuara,' signifying the sun, because it bears flowers of a flame color. The kuara beans have been used from time immemorial to weigh gold. The beans when dry vary hardly at all in weight, so that they are safe to use for this purpose. They were transported into India at an early date, and came in use there for weighing diamonds. We do not use beans, but we keep the word, the carat being about two hundred and five and a half milligrammes, or a small fraction less than four grains."

"I should like to know something about the great diamonds of the world," said Estelle.

"The big sparklers, I suppose you mean," said Jessie.

"Those that are full of carrots?" suggested Fritz.

"No, but of carats," said Tom. "You must change your pronunciation a little. I think that Estelle would likely prefer the mineral to the vegetable kind."

"Yes, indeed," said Estelle. "Can you not tell us about the great gems, Inez?"

"Not to-day, I fear. I shall have to freshen up my information a little. It is a long story, and you must let me off till a later date."

"Then tell us about the small ones," said Fritz.

"Probably some of the smallest have come to us

from the remote depths of space," said Inez. "It is odd to think of diamonds flying to the earth from the far-off region of the fixed stars, yet such seems to be the case. At any rate, diamonds are said to have been found in some meteorites, or stones fallen from space. They are so small, however, that it needs strong microscopic power to see them. Other very small ones are those that have been made by artificial methods."

"I was going to ask you about them," said Fritz. "We know, of course, that the diamond is a crystal of carbon, and that many crystals are made in the laboratory; and I thought it very likely that diamonds might be thus produced."

"So they have; but they are very minute; far too small to have a market value."

"And can you tell us how it was done?" continued Fritz.

"It has been accomplished in several ways, I think," said Inez. "In a recent experiment at Paris, of which I have read, iron containing an excess of carbon was fused, and then suddenly plunged into a bath of molten lead. As a result, small crystals were formed, which had all the properties of the diamond. These crystals were found to have a specific gravity of about three and a half, which is the same as that of the diamond; they would scratch sapphire, burn in oxygen at a temperature of nine hundred degrees, and give about four times their weight in carbonic acid. These are the properties of the diamond; and there can be no question that the very great pressure

to which the carbon was subjected had caused it to crystallize."

"You have spoken of white, yellow, and black diamonds," said Tom. "Are there diamonds of any other colors than these?"

"They have been found of almost every color under the sun," said Inez. "The rarest are those of the red or ruby tint. According to Thomas Nicols, 'The red diamond feeds your eye with much pleasure in beholding, and hence are discovered to us the excellencies of supercelestial things.' Only one diamond of the peculiar ruby tint is known. It is called the 'Halphen red diamond,' and is now in possession of a wealthy collector of gems in London. Rose-colored or pink diamonds are plentiful. As for green diamonds, as well as those of other colors, the most complete collection is on exhibition in the Vienna Museum. In the Green Vaults of Dresden there is on exhibition a green diamond weighing forty-eight and a half carats, and valued at one hundred and fifty thousand dollars."

"I have certainly read somewhere a curious story about a green diamond," said Estelle; "but, as usual, I have forgotten it. I am sure, however, that Inez, who forgets nothing about precious stones, can relate it."

"I fear I have forgotten more about them than you ever knew," laughed Inez. "But I can give you the history of the brilliant green diamond in question. About thirty years ago, a stone was thrown out of a package of emeralds by a jeweller about

to make a purchase, and who rejected it as an off-colored emerald. It was bought for a small amount by the English consul at Vienna and discovered to be a diamond. He sold it to an expert for the sum of one thousand dollars, who afterwards disposed of it to a diamond broker for one thousand five hundred dollars. It then came into the hands of a London jeweller, who sold it to an American for three thousand dollars. The American has frequently refused eight thousand dollars for it.

"Blue diamonds, that is, those having a faint bluish tint, are not rare. Only occasionally do they rank as fine gems, as they are usually more or less opalescent. Among the blue specimens, the Hope diamond comes first of all, it being of a dark indigo-blue and weighing forty-four and a quarter carats. There are two other well-known blue diamonds. These are of the precise color of the Hope diamond, and, in fact, are supposed to be portions of the original Hope diamond, having been cleaved from it and set aside by a dishonest lapidary.

"Imitation diamonds are mostly made in Paris, and are known to the trade as 'French paste.' They often closely resemble the real article, and many more of them are worn than you would imagine. Some persons who are known to possess valuable diamonds keep them in places of safety and wear paste imitations instead, knowing that they cannot be detected except when examined and tested by an expert. They are made from strass, which has been described to you. Diamond doublets are also in the

market, having for the upper side a thin slab of garnet."

The party had been too deeply interested to notice the flight of time, and it was late in the evening when Uncle Ben entered the library, looking at his watch.

"Have you folks any idea of the time?" he asked.

"Oh, yes," said Tom. "It must be at least nine o'clock."

"Why, my dear boy, it is now fifteen minutes after eleven," said Uncle Ben.

There was a general exclamation of surprise at this.

"Then the time must have flown; it did not go at its usual sober gait," said Fritz. "I, for one, had no idea it was so late. Inez must be tired; but I don't believe she has tired any of her listeners. I want to offer her a vote of thanks."

"As judges of the Supreme Court say, 'I concur,'" said Tom.

"And I, too," followed Jessie. "I knew that Inez was well versed in the subject of precious stones, but did not expect that she could talk about them quite so like a book. She has given us a real treat."

"I certainly know more now about my birth-stone than I ever did before," said Estelle. "You should know, Mr. White, that it is the diamond, and that this stone has been the subject of our talk."

"Before saying good-night, Inez," said Tom, "I wish you would tell us some reliable way of testing a diamond."

"The best and most reliable test," said Inez, "is

its quality of easily scratching a sapphire. As you have been told, the sapphire will in turn scratch a topaz, the topaz will scratch quartz, quartz will scratch glass, and so on down the scale of hardness."

"But suppose I wanted to test a diamond, and did not have a sapphire,—and I really do not have many of them lying around loose,—is there no other or more simple way of applying a test?"

"Yes; I might name several ways; but there is a test which has not yet been published to the world, and of which you shall have the first knowledge. Rub a piece of aluminum (which is now plentiful and readily obtained; much more common than sapphire) on glass, and it will leave a mark that it is impossible to wash away. It does not scratch the glass, but adheres to it so firmly that it can only be removed by an application of strong acid. Now try to make a similar mark on a diamond with aluminum, and you will find that it leaves no trace. You can therefore readily understand that this is an infallible test for distinguishing a diamond from any imitation of that stone. The adhesion of the metal on glass is absolute."

"So much for your stone jewels," said Fritz, looking towards the two lovely visitors. "But we have here some diamonds of the first water and many carats' weight that need to be cared for as well as your Koh-i-noors and Regents. As the hour is late, I beg leave to see them safely home."

"What! Do you mean us?" exclaimed Jessie, with a smile of mingled pleasure and amusement.

"Exactly. I do not see any other gems outside of Inez's cabinet."

"Well! how about Inez herself? Your compliment is a little too heavy and off-colored, Mr. Mayer. And as the streets of Denver are safe and we are not likely to be stolen as diamonds, I think we shall not put you to so much trouble."

"Are you quite sure the streets are safe?" asked Tom.

"Quite sure," answered Estelle.

"Then I had better go along, too. If they were not quite safe, I should not like to trust my precious self out at this late hour."

A merry laugh followed, after which "good-night" was said by all except Tom and Fritz, who ignored the words of the visitors in favor of the invitation which they read in their looks.

CHAPTER X.

BLOW-PIPE TESTS, AND A TALK ON COPPER AND IRON.

WHEN the boys entered Uncle Ben's private laboratory and assay office next morning, they found their cousin Harry seated at a table on which were an alcohol lamp, several square pieces of charcoal, and a few small bottles containing chemicals used in fluxing the ores to be tested. In his hand he held a silver-plated blow-pipe with a platinum tip.

"Good-morning," he said. "You see I haven't forgotten. I was afraid, though, that you might forget after your outing with the belles of Denver last night. You see I have prepared the table, and am ready to show you some simple examples of testing minerals with the blow-pipe."

"Forgotten it! Not I," said Tom. "I have looked forward to this lesson on the blow-pipe with a great deal of hope of new knowledge."

"And so have I," said Fritz. "One must feel a satisfaction in picking up a piece of rock or metal and in a few minutes be able to learn what chemical substances it is made of, as I have often seen you do."

"I have always found it interesting," said Harry. "But then I have lived among minerals. Suppose we get to work at once. To begin with, I will light

the wick in this alcohol lamp and commence operations by placing a small piece of lead on charcoal, on the end nearest the flame. This will allow ample space for the coating driven off by the blow-pipe to deposit beyond the specimen. You must bear in mind that the reducing flame is that part which lies at the point of the inner or blue flame, and that the oxidizing flame is the outer or yellow flame. You can see the marked distinction between these two sections of the flame." He was blowing the flame of the lamp with the blow-pipe as he spoke. "I will now blow downwards at an angle of fifteen or twenty degrees directly upon the lead. You will perceive that it is easily reduced to a molten mass, and that the charcoal is covered with a yellow deposit, while outside of the yellow there appears a bluish-white coating. The yellow coating on the coal is oxide of lead and the bluish white is carbonate of lead. Have you made note of that?"

"Yes," they both answered.

"Very well. I now direct the flame on the yellow coating. You see that it quickly disappears. It has been reduced to metal under the flame and again oxidized beyond. The flame, as you see, is colored an azure blue. These coatings on the charcoal are characteristic, and it would be well for you to take notes of all these points as we proceed."

"You said that the yellow coating was oxide of lead," remarked Fritz. "Is not that the substance which is used in the storage battery for the storage of electricity?"

"There are two oxides of lead," said Harry, "the yellow and the red,—the first called litharge and the latter minium. The one you see is litharge, but it is minium that is used in storage batteries. Well, so much for lead. Now let us take a small piece of zinc. You will notice that it fuses readily, at the same time giving off a greenish-white flame and white fumes. The charcoal is heavily coated with a white substance, which is an oxide of zinc. It is yellow while hot, but changes to white as it cools, and then becomes infusible."

"What are the uses of the oxide of zinc?" asked Tom.

"Its principal use is as a pigment," said Harry. "It takes the place of white lead, and yields a beautiful creamy-white color. It is also largely employed in cosmetics, for medical purposes, and in putty. Now suppose we turn the charcoal over to a fresh surface and try a fragment of tin. This, you see, also fuses quickly under the blow-pipe. You will observe that when I use the oxidizing flame the molten tin is covered with a pale yellow coating. This, as in the former cases, is an oxide; oxide of tin, this time. The white coating that hugs close to the metal, and forms a ring near and around it, is reduced to metallic tin when played upon with the reducing flame. Take the magnifying-glass and tell me what it looks like."

"It seems to me much like tiny globules of quicksilver," said Tom, after a careful look through the glass.

"I think that hereafter I shall, with the aid of a blow-pipe, be able to distinguish tin from either lead or zinc," said Fritz. "It is easy enough when one knows how to do it."

"Exactly. Just as easy as it was for the Spaniards to make an egg stand on end when Columbus had shown them how to do it. We will now take a fresh piece of charcoal and try a fragment of the metal antimony." Harry did as he had said, and blew through the blow-pipe upon the flame. "Like the preceding metals, you see that it melts quickly, and fuses under either flame, coating the charcoal bluish white. By gently heating it this coating is driven away, its fumes tinging the flame a pale-green color. Antimony when once fused takes a long time to cool, and just before cooling becomes coated with white pearly crystals.

"Tellurium to the unpractised eye is almost like antimony in its behavior on charcoal. To show you its action, I will take the other side of the coal and try a small specimen of sylvanite, which, as you have been told, is the telluride of gold. Like the antimony, it melts readily and gives the coal a white coating, which is tellurous acid. But in this instance the coating on the charcoal has a yellowish-red border. When I now apply the oxidizing flame, this coating is driven from place to place on the coal, and is dispersed by the reducing flame with a green color."

"I see some tiny yellow specks on the tellurium," said Fritz. "What are they?"

"They are gold which has been set free from the tellurium by the flame of the blow-pipe. I have here another metal, that known as bismuth. It is fused more easily than any of the other metals, and, as you may perceive, coats the charcoal a dark orange yellow while hot, and a light lemon color when cold. It does not color the flame as the other metals did."

"Several years ago I was presented with a set of spoons," said Fritz, "that melted in hot tea. It was intended as a joke on me, though I could not see much to laugh at in it. They were said to have been made of bismuth."

"I have read of such spoons, and such jokes, too," said Harry. "They are not pure bismuth, but are made from an alloy of this metal with lead, tin, and cadmium, known as fusible metal. It fuses below two hundred and twelve degrees Fahrenheit; that being the boiling point of water. Here is some arsenic. Do you notice the peculiar odor of garlic when I try it under the blow-pipe flame? That is a well-known test for arsenic. The white coating formed consists of arsenious acid. You perceive that it is visible some distance away from the specimen treated. It volatilizes without fusion. Selenium, which gives off brown fumes, is also known by its odor, which resembles that of rotten horseradish." Harry proved this by experiment.

"Next we will fuse a piece of pure silver on clean charcoal," he said. "It is not so easily fusible as the other metals tested, but in a short time, as you

notice, it yields to the reducing flame and forms a button or globule. When played upon by the oxidizing flame, this coats itself with red oxide of silver. Upon cooling, the button contracts rapidly and usually vegetates, as we call it; that is, it throws out little sprigs from the surface of the button. Shall I go on with the metals?"

"Yes, indeed; if you stop now, I will discharge you and hire another teacher," said Fritz.

"Well, after so dreadful a threat as that I had better go on. Suppose we try copper next. You see that it gives to the flame an emerald green color, and coats the specimen with a red oxide of the metal."

"How about gold?" asked Tom.

"Gold melts easily in the reducing flame and is unaltered, yielding no coating or oxide."

Harry proved this fact by experiment with a small fragment of gold.

"Soda," he continued, "when melted in the reducing flame, gives an intense reddish-yellow color to the oxidizing flame; and potash, rubidium, indium, and cæsium all give it a violet tinge. A red flame is produced by only three minerals, these being strontia, lime, and lithia. The lithia yields a flame of carmine red; strontia colors the flame first a pale yellow and then a crimson; lime, in the state of chloride, produces a faint red flame.

"Green flames are produced by copper oxide, baryta, boracic acid, molybdic, phosphoric, and tellurous acids. These differ somewhat in shade of

color,—oxide of copper giving a green flame, boracic acid one of yellowish green, while borax when moistened with sulphuric acid yields an intensely green flame. Tellurous acid colors the flame pale green, and baryta, as a chloride, gives a pale-green flame, which after continued blowing changes to bright yellow green. Molybdic acid yields yellow-green flame, and a leaf or scale of the mineral molybdenite gives a pale-green flame and is not fused. The phosphates give a blue-green flame, sometimes only for an instant.

"Pyromorphite, or phosphite of lead, gives a blue flame with a green tip. Blue flames are also produced by antimony, arsenic, bromide and chloride of copper, and lead. Of these, arsenic is surrounded with a light-blue flame, the chloride and bromide of copper produce first a blue and finally a green flame, and lead is surrounded by a blue flame.

"There, that is all I think it wise to say at present. To tell you too much at once may overload you with facts, and these, like other things, need time for digestion. I should advise you to supply yourselves with blow-pipes, alcohol lamps, charcoal, borax, soda, and salt of phosphorus. A small piece of platinum wire is also a necessity, and small forceps for holding the wire. You must, besides, purchase some standard book on the blow-pipe, for I have only led you over the threshold of the subject. You will discover as you proceed that it is inexhaustible. After lunch, I think father intends to take you in hand on the subject of copper and

other metals. And now, fellows, if you don't mind, I will come down from my seat of dignity and let you see that the grave and reverend professor is a boy still, under his tutor's cap."

For the next few hours the cousins entertained themselves in ways suitable to youth and high spirits. Mr. White, who had been out all the morning, returned home to lunch, and after this was despatched invited his young visitors to the library, saying that he had leisure for a brief lesson on their favorite topic.

"How have you been entertained since I saw you last?" he asked.

"Inez took us in hand yesterday," said Tom; "showing us her cabinet of gems, and giving us an entertaining talk on them; and this morning Harry has given us a good start in the uses of the blow-pipe."

"It is well that you should go on with that," said Uncle Ben. "The blow-pipe is of much importance in mineralogy, and is justly called the dry analysis. If you would like, I will tell you a little about copper, a metal which has been known from the earliest ages and is frequently spoken of in the Bible. We find it there stated that Tubal Cain was the first worker of brass, of which copper is the principal part. Palestine indeed abounded in copper, and King David used immense quantities of it in building his famous temple. All sorts of vessels and weapons of copper were made in the temple and tabernacle. As the ores of copper are usually in beautiful colors,

or very heavy, it is not to be wondered at that they early attracted attention. In ancient times, however, copper, so far as we know, was not employed by itself, but was alloyed with other metals, such as silver, zinc, and tin. When alloyed with the latter metal it formed what is now known as bronze. Very probably it was at first used by itself; and we know that this was the case in America, where the early Indians used native copper for various purposes. Copper was most abundantly mined for in those days on the island of Cyprus, from which comes the Latin name for copper (*cuprum*), and from that is derived our word copper. There is abundant evidence to show that the ancient Britons worked the copper mines of North Wales. Copper is found in many parts of the world, being one of the most generally distributed metals. It is very abundant in the United States, whose yield is more than half that of the world. The oldest known mines are those of Michigan, which were worked by the Mound Builder Indians; but Montana yields the largest quantity. Arizona is also rich in copper. The ores of copper are numerous, the most common being the pyrites or sulphuret of copper.

"Native copper is found occasionally in nearly all copper mines, and is mostly of a copper red color, though sometimes black, brown, and of various other colors. The native metal is not often found in large masses, though a specimen weighing two thousand and twenty pounds was found in Brazil. The museum of the Academy of Sciences at St.

Petersburg has on exhibition an enormous mass of copper which was found in Kamtschatka, and there is a specimen in Canada which measures fifteen feet in circumference."

"I believe that many of the metals are soluble," said Fritz. "Is that the case with copper?"

"Yes; it is quite soluble even in ordinary water. The water flowing from copper mines, in fact, always contains copper in solution. This was first noticed when the celebrated copper spring in Wicklow County, Ireland, was discovered, about the middle of the eighteenth century. The discovery was due to a miner, who, having left an iron shovel in the water of the mine, found, on its recovery a few weeks afterwards, that it was heavily coated with copper. This accident suggested the laying of iron in the stream that copper might be deposited on it, which was done with good effect. This fact, that the metal is deposited in its native state upon iron from a solution of copper, furnishes the miner with a simple test for that metal. A drop or two of nitric acid is placed upon the specimen to be tested and allowed to remain a few minutes, after which one needs but to moisten the blade of a knife and draw it across the spot where the acid was placed. If the specimen contains copper, the knife-blade will be coated with that metal."

"Well, that is certainly very interesting," said Tom. "I am afraid I shall be coppering all my knife-blades, if I ever find myself in a copper country."

"Copper is largely employed in the arts," continued Uncle Ben, "as a sheeting for the bottoms of ships, for all kinds of utensils, and for telegraph, telephone, and electric wires, it being nearly the best known conductor of electricity. Silver is a little better. You know, of course, that it is in general use for trolley-car wires, both from its high conductive power and its resistance to oxidation or rusting. Alloyed with zinc, it forms brass, and with tin it produces gun-metal, bronze, bell-metal, and speculum-metal. It is used in gold quartz mills in the form of a plate amalgamated with mercury, to hold the particles of gold as they pass over it.

"Oxide of copper is employed in glass factories to give the red and green colors to their wares. As a sulphate, copper yields the well-known blue vitriol or bluestone, sometimes also known as blue copperas. This is largely used by the dyer and calico printer, and also in the electrotype process and in galvanic batteries. Finally, copper is employed extensively in all civilized countries for coinage."

"The old copper cents, nearly as big as a silver dollar, went out of use before my time, though I have seen them," said Fritz. "What a nuisance they must have been when one got a lot of them! Don't you suppose that a large number of copper coins are lost?"

"Yes; a much larger number than is generally supposed. It is estimated that one hundred and nineteen million copper pennies have been lost to circulation in the last hundred years. But I must

not spend all my time talking about copper in its metallic state. There is much of interest in its ores, or chemical compounds. Here is a specimen of copper pyrites, the most abundant of all the copper ores. But I believe we have already considered that from the specimen in Tom's box. Didn't we also take up malachite and azurite at that time?"

"Yes," said Tom; "I have all that down in my notes."

"Then we will take up this specimen of gray copper ore, whose technical title you may jot down as tetrahedrite. Its usual color is steel gray, like that of this specimen. It is composed of copper, iron, and sulphur, and sometimes also contains arsenic, antimony, zinc, and silver. In fact, it is often very rich in silver, containing as much as thirty per cent. of the precious metal. It fuses readily before the blow-pipe on charcoal, yielding a button of copper."

Putting it back, Uncle Ben took out a blackish substance from the open drawer of his cabinet.

"Here is another specimen of copper ore which the miners call 'copper glance,'" he said. "It is known also as vitreous copper ore. It is gray black in color, and is heavier and softer than gray copper. The blue and green specks which you see in it are due to oxidation. The composition of this ore is copper and sulphur, and it is so easily fused that it will melt in the flame of a candle or alcohol lamp without the aid of a blow-pipe.

"Here, now, is another ore, and a very beautiful

one, called chalcotritchite," he continued, taking up a brightly colored mineral.

"Please say that again, and say it easy," interrupted Tom.

"It is pronounced this way. Kal-ko-tritch-ite," answered Uncle Ben. "All the cavities in this rock are filled with brilliant, transparent, ruby-colored needles. When examined through a microscope, each of the needles presents the appearance of a gigantic ruby. I have no microscope at hand, but even with this small magnifying-glass you will see a rare sight. It is an oxide of copper, and certainly one in which nature has sought for beauty as well as utility. Here is another handsome ore, bright green in color. This we call chrysocolla, it being a silicate of copper. On account of the large percentage of silica and small amount of copper contained in it, it is not a profitable ore to work for the metal, but is so attractive in appearance that it is often cut and polished for gem stones."

"How do you get at the percentage of metal in the different ores?" asked Fritz. "Is there not some simple method for testing copper ore to get at this result?"

"Yes; more than one," answered Uncle Ben. "The simplest method I know of is one I witnessed in Chihuahua, Mexico, it being the invention of a Mexican miner. This man used two white glass bottles which held about one quart each, and were precisely alike. With these he used a common metal screw cap such as are found on ketchup bottles. He

found that each of these bottles would hold more than one hundred screw-caps full, and proceeded to graduate his two bottles in this way. He filled the screw-cap with water and poured it carefully into one of the bottles, and then marked the level of the water in the bottle with a file. Filling the cap again with water, he emptied it a second time into the bottle and marked another notch with the file. This operation was kept up until he had made one hundred notches, each tenth notch being longer than the others. He then proceeded in the same manner with the other bottle.

"Now for the test. Having obtained some pure copper wire, he weighed out exactly one hundred grains, which he dissolved in nitric acid and poured the solution into one of the bottles. The liquid was green. He next poured ammonia into the bottle until it yielded an odor of ammonia; which does not appear until the acid is neutralized. The color of the solution now became changed to a deep blue. Distilled water was next added till the liquid rose to the one-hundredth notch on the bottle, the blue color of the liquid becoming lighter as the quantity of water increased. The bottle when thus prepared is called the standard solution, or one hundred per cent. copper.

"The next step in the process was to pulverize some copper ore, of which he weighed out one hundred grains, placing it in a glass tube containing nitric acid. The liquid boiled briskly as the copper was taken up by the acid. After sufficient time had

elapsed to allow the liquid to cool and the sand to settle, the solution was poured into bottle number two. The solution was green in color, and contained all the copper of the rock, the acid having dissolved it out from its matrix. Ammonia was then poured into the bottle, as was done with bottle number one, the liquid, as before, changing to a deep blue.

"He now placed both bottles side by side where the light could shine through them, and poured water into bottle number two until the shade of blue was precisely the same as the color in number one. The final process was to count the notches upwards to where the liquid stood level in the second bottle, and the number counted was the percentage of copper contained in the ore."

"That is to say, as I understand it," remarked Fritz, "that, if he had taken fifty grains of copper instead of the ore, it would have given the same color as number one when it reached the fiftieth notch?"

"Exactly. That is the principle of the test. I see you understand it."

"Well, it is certainly a simple one," said Tom; "and yet how ingenious."

"Yes; a very simple one," answered Uncle Ben; "but it cannot always be relied upon, for the presence of certain minerals would affect the color produced. But after many trials I am satisfied that it is reliable nine times out of ten, the result invariably yielding a slightly higher per cent. than is obtained by the fire assay. Of course, all depends on a quick

and true eye for shades of color. Persons who are the least inclined to color blindness cannot make the test."

"Is this another copper ore?" asked Fritz, pointing to a specimen in the case which lay next to those taken out.

"Why, no; that is iron, and has no business there. It has been carelessly moved out of place. Here is where it belongs." He drew out another drawer containing samples of iron ore and put the specimen in its proper place.

"Iron ores seem somewhat numerous," said Tom, looking curiously into the drawer. "Have you anything to say about iron?"

"It is a large subject," said Uncle Ben, "but a rather well-known one. Perhaps I can give you some new points.

"In an industrial sense iron is the most valuable of all metals, and is the most widely distributed. It is the coloring matter of most substances, and is found not only in the earth, but even in your blood, whose red color is due to iron. There is no substance that has so many uses. It can be cast or moulded in any form, and is capable of being drawn out into wires of any length, or rolled into sheets and plates. It can be sharpened into knife- and sword-blades, and hardened or made soft at will. Tall buildings and prodigious ships are made from it; an enormous amount is in use as railroad iron; and thousands of miles of iron pipe for water and gas purposes have been laid in the large cities of the world. As a

medicine, it has much virtue, it being very important to keep up the normal percentage of iron in the blood.

"Iron was known in the early ages, and is frequently mentioned in the Bible. Tubal Cain, the seventh in descent from Adam, is said to have been the first worker of iron and brass. Furnaces for melting iron ores are mentioned by Moses; and swords, knives, axes, and all instruments for stone-cutting, were made from iron in his day. The Canaanites, fifteen hundred years before Christ, are said to have used chariots of iron in their wars. In former times the workers of iron were important persons, and were treated as officers of the highest rank, and in some mythologies the smith has a place among the gods. In the royal court of Wales the blacksmith sat in the royal chamber with the king and queen, and was entitled to a sup of all liquors brought to the chamber. It was he who forged the coats-of-mail for knights and war-horses, and in those days, when war was one of the most common occupations of the higher classes, the work of a clever smith might be a matter of life and death to its wearer.

"The importance of the blacksmith in Scotland during the Middle Ages is well illustrated by the following story. A blacksmith had committed a capital crime; the jury brought into court a verdict of guilty, and the judge sentenced him to death. But his employer sent a message to the authorities stating that it was impossible to dispense with the

smith's services, and offering to send them two weavers to be hung in his stead. I cannot say what became of the weavers, but you may be sure that the smith was not hung.

"Iron is the most tenacious of metals. An iron wire one thirty-sixth of an inch in diameter will sustain a weight of sixty pounds. Of the ores of iron, that known as hematite, or red oxide, is found in great abundance in nature, and is the most valuable of all the iron ores When artificially prepared, it is known in the arts as 'rouge,' 'crocus martus,' and 'colcothar.' It is used as a pigment, and is employed as a polishing powder by lapidaries and stone-cutters. As rouge it was formerly much prized by ladies in giving their cheeks and lips a ruby tint. The women of the Orient still use it for that purpose. It is also the war-paint of the Indians.

"The sulphate of iron is the well-known green copperas. Tannic acid changes it to a black color, which is tannate of iron. Large quantities of tannate of iron are employed in dyeing and in the manufacture of writing ink. But the ores of iron are too numerous and too common to mention, and the subject, I fear, would prove uninteresting to you. Probably, indeed, between me and Harry, you have heard quite enough for one day's sitting, so, if you don't mind, I will let you off till to-morrow."

"I think we ought to be much obliged to you for giving us so much of your valuable time," said Tom.

"I would not care to do so for everybody," said Uncle Ben, genially; "but it is a pleasure to have

two such attentive listeners. I do not mind spending time and breath where I think it is doing good."

"You have certainly succeeded in that," said Fritz. "You make me feel as if I were on the brink of an ocean, of which so far I have only taken a few sips from the coast waters."

"A happy illustration," said Uncle Ben, with a warm smile. "I have been drinking from that ocean for half a lifetime, and it seems as full as ever. I hardly think all mankind will exhaust it soon. The field of knowledge is practically endless, man's power of absorption limited; the best I can hope to do is to start you on the path."

"But that is a great deal to do," said Tom, enthusiastically. "I didn't even know there was such a broad path leading in this direction till I came to Denver."

After a few more words the session came to an end.

CHAPTER XI.

METALS, SAPPHIRES, AND EMERALDS.

On entering the library the next morning, Tom and Fritz found their uncle Ben there before them, studying a tray of specimens he had taken from one of his cases.

"It was my intention," he said, "to have Inez give you a talk on gems this morning, but she says that she is not feeling well, and begs to be let off until after dinner. As I have a spare hour, I do not mind taking her place, and have chosen a heavy subject for our morning talk, that of lead."

"That will do very well," said Tom. "About all I know of it is that it is made into bullets and shot."

"Lead is one of the softest, heaviest, and, with the exception of iron, the most widely diffused of all metals," began Uncle Ben. "When newly melted it is very bright, resembling tin, but on cooling it soon becomes tarnished, and assumes the dull bluish color known as lead-gray. Sheets of lead were in use in ancient times for writing upon. That, you know, was before paper came into use. Hesiod, one of the early Greek poets, supposed to have been born in the eighth century before Christ, is said to have written seven of his books on sheets of lead. Pliny, born A.D. 23, tells us that the laws were pre-

served on plates of lead in his time. Paper, or rather papyrus, the Egyptian substitute, was plentiful in his days; but doubtless lead was used as being more durable. In the book of Job the following expression is used; Oh, that my words were now written! oh, that they were printed in a book! that they were graven with an iron pen and lead, in the rock forever!"

"Why, how curious!" cried Tom. "I am sure I never heard of lead books before."

"In 1699 an ancient book composed entirely of lead was purchased in Rome," continued Uncle Ben. "It was four inches long and three inches wide, and is certainly a most valuable relic of old times. In these days it is hard to imagine the use of lead in place of paper. Lead is the most malleable of all metals, and is spread out into sheets with the greatest ease under the hammer. It does not get harder nor is its specific gravity increased by hammering, as is the case with gold. In ancient times lead was smelted on high hills, by fires of charcoal and wood, which were kept alive by the wind. These ancient smelters were termed 'boles.'"

"How came they to get that name?" asked Tom.

"A bole means the trunk of a tree. I don't know the application. Hollow tree trunks may perhaps have been used in some way in the process."

"What is lead used for?" asked Fritz. "Besides making shot and for writing purposes, I mean?"

"It has many other uses," answered Uncle Ben. "As an oxide it is used in glass making, it giving

toughness to the glass and making it easier to cut without breaking. Lead also gives to glass a greater power of refracting the rays of light, and renders it capable of receiving a high polish."

"Is that the reason it is employed in the manufacture of artificial diamonds?" asked Tom.

"Yes, that is the reason. If you place a French paste imitation diamond on charcoal just beyond some lead, and direct the flame of a blow-pipe on the lead in such a manner that the oxide or fumes will strike the stone, it will give it added lustre, but will darken the stone. Pewter, a very common and useful substance, is composed of a mixture of lead and tin, and so also is the soft solder of plumbers."

"How are shot made?" asked Fritz.

"The process is a very simple one. Molten lead is poured into a sieve, through whose meshes it passes in small drops, and is caused to fall from a high tower into water. The idea is said to have originated in the dream of a plumber's wife. Small shot are composed of an alloy of lead and arsenic, the latter in a small quantity; this hardens the lead, which becomes perfectly round in falling. Without the arsenic they would be elongated and pear-shaped. Lead melts at a very low temperature, and this makes it the best metal for casting type. But as it would be too soft for that purpose, an alloy is made, composed of four parts lead and one of antimony, which is sufficiently hard. The bullets used in shrapnel shells are made from a similar alloy, as bullets made of lead alone would be so soft that in

firing them from the mortar they would be jammed together in a mass. Only one of the compounds of lead is employed for medical purposes. That is the acetate, commonly known as the sugar of lead. All compounds of the metals are poisonous; but, for that matter, many substances which are used for medicine are poisonous. The secret is to take them in doses small enough to be safe."

"I once saw a very beautiful crystallization in a jar of water," said Fritz, "which I was told was called the 'lead tree.' Can you tell us how it was made?"

"It is produced," said Uncle Ben, "by dissolving one pound of sugar of lead in a jar full of water, and then suspending in the water a bar of zinc, or some sheet zinc rolled up. The zinc will be instantly covered with minute crystals of lead, which increase in size rapidly, and in twenty-four hours will extend to three or four inches in length. It makes a pretty ornament for window decoration; but it should not be moved, as the crystals are easily shaken off."

"Are there many ores of lead?" asked Tom.

"Yes, they are very numerous," was the reply. "The sulphide, known as galena, and the carbonate, or cerusite, are the principal ores from which the lead of commerce is obtained."

"What ore of lead are lead-pencils made of?" asked Tom. "I am sure they cannot be pure lead. They are too soft for that."

"You can well be sure of that," said Uncle Ben,

with a smile, "as they have no lead in their composition."

"No lead? But they are called *lead* pencils!"

"They are not the only things called out of their true name"

"Then what are they made of?"

"That question belongs to Inez rather than to me," said Uncle Ben, "since the substance used in the lead-pencil is first cousin to the diamond, and is no relation to lead, though it is generally known as black lead. It is really a mineral called graphite, or plumbago, which I will explain to you later on. There, I fear I shall soon have to stop," looking at his watch. "I presume that Harry has shown you how to test for lead with the blow-pipe?"

"He has that," replied Fritz, "and given us a good many other tests. I wish I was only half as expert in that work as Harry. We are greatly obliged to you, uncle, for all you have told us about the metals, but will you excuse me for saying that there is one of the every-day metals of which you have not spoken."

"What is that?" asked Uncle Ben.

"Tin."

"Is it possible that I have passed by that?"

"Without a word."

"Well, that is doing great injustice to a very useful servant of man. It will never do to leave tin out of our list."

"Or out of our pockets, either," said Tom, "if we take the slang meaning of tin as money."

"We mineralogists do not indulge in slang meanings," said Uncle Ben, reprovingly.

"Then I will have to give them up when I get to be a mineralogist," rejoined Tom. "So far I am but a beginner."

"Tin is found in a good many places," began Uncle Ben, "though it is not so common as some of the other metals. Either tin or tin ore must have been known in very early times, for the old bronze tools and weapons contain this metal, and these were in use thousands of years ago. We do not know when the metal first came into use by itself, but ingots of tin and articles made of it have been found in the Swiss Lake dwellings more than two thousand years old."

"Where did this tin come from?" asked Tom.

"Most likely from Cornwall, England, though tin is found in some other parts of Europe. Pliny speaks of Cornish tin, and the British isles were known to the ancients as the Cassiterides, or the Tin Islands. Tin is still mined in Cornwall."

"Where else is it found?" asked Fritz.

"The purest ore comes from the island of Banca, in the East Indies, and important deposits have recently been found in Australia and in the Malay Peninsula. The latter now furnishes more than half of all the tin produced."

"How about America and the United States?" demanded Tom. "You don't mean to say that we have no tin!"

"Plenty of it, if we chose to mine it. Tin is

found in several parts of South America, and there are rich deposits in this country. It is found in Virginia, North Carolina, and California, but the richest bed of ore is in the Black Hills, South Dakota, where it is found in a stone that was formerly thrown away by the miners as useless and troublesome. High hopes were entertained from this deposit, but it proved too costly to extract, and no tin is now mined in this country."

"In what form is tin found?" asked Fritz.

"In what is known as tinstone, which is an oxide of tin, and is found as a very hard mineral of a dark brown or blackish color, often in the form of crystals. What is known as wood-tin looks something like dry wood. Tin, like gold, is found both in veins and in alluvial or placer deposits, whose tin has been washed out from the veins. This is known as stream-tin."

"Is it difficult to extract from the ore?" asked Tom, who had been making active use of his notebook.

"Why, the process is a somewhat complicated one," answered Uncle Ben. "Tin is mixed in the ore with a large number of other minerals, and has to be subjected to stamping, washing, roasting, and other processes to rid it of sand and earth, arsenic, sulphur, copper, iron, and other impurities.

"The ore is then mixed with broken coal and a little lime, to form a slag with the silica, and heated in a furnace. The tin melts first, and afterwards the slag. This floats on the surface, so that the melted

tin may be drawn off below. Still other processes are necessary to get rid of all the arsenic, iron, and other metals. The purest tin produced is called *grain-tin.* It becomes brittle when near its melting-point, and if struck with a hammer it breaks into fragments. The less pure tin is known commercially as *block-tin.*"

"I should judge, from something you said, that tin is easily melted," said Fritz.

"Yes; it is the most fusible of all the commercial metals. It melts at 455° Fahrenheit. This is considerably below the melting-point of lead, which we look on as very fusible."

"It seems to me I have seen somewhere the phrase 'the cry of tin,'" said Tom; "though I don't know what makes it cry."

"That is a peculiar crackling sound it makes when we bend it backward and forward. It is due to the friction or the crushing of its internal crystals. It is easy to obtain crystals of tin of considerable size. I have some here." He took some specimens from his cabinet and laid them out for inspection.

"Tin, as you know," he continued, "has a silvery white color, and objects made of it are brilliant when new or freshly cleaned. It does not tarnish readily. In fact, it is the least acted on by air and water of all the common metals, and this makes it useful for a great many purposes."

"Such as making tin cans and putting on roofs of tin," said Fritz; "and, of course, tin pans and

cups, and the like. It is sad to think how much is wasted in the form of old tin cans."

"Much more iron than tin," said Uncle Ben. "These articles are made of tinned iron, or iron covered with a thin layer of tin, so as to protect it from the air. Tin is also used to coat the inside of cooking vessels, for it is not acted on by vinegar or fruit acids. Some vessels are made entirely of tin, and block-tin is often used to make gas-pipes for houses."

"Are these the only uses?"

"By no means. An important use is in the making of several valuable alloys, such as bronze, gun-metal, bell-metal, Britannia metal, Queen's metal, and the various solders. Also, as an amalgam, it is used in 'silvering' mirrors."

"And as tin-foil?" suggested Tom. "There seems to be a good deal of this used."

"Yes. Tin is not tenacious, but is very malleable, and may be hammered out as thin as one one-thousandth of an inch. Tin-foil is made either of tin alone or of an alloy of tin and lead, and millions of pounds of it are produced every year in the United States. It is very useful in wrapping up small articles so as to exclude the air. It is sometimes painted, and is often handsomely embossed, or it may be lacquered with gold or in brilliant colors. The finest foil thus produced sells as high as seventy-five cents a pound, though ordinary foil is very cheap."

"And now, Uncle Ben, I want to ask you about

another common metal," said Fritz. "It is one that we hear much about nowadays, though I believe it is a late comer. I mean the very light metal, aluminum."

"Yes, that certainly needs to be considered," said Uncle Ben. "Though it has been cheap enough for use only about ten or fifteen years, it is really one of the most abundant metals of the earth, its oxide being the basis of all the vast deposits of clay. But oxygen holds on to it so strongly, and is so hard to drive off, that aluminum or aluminium—it is spelled both ways—has long been a very costly metal."

"If oxygen holds on so strongly, it ought to take hold again easily," remarked Tom.

"No, by good fortune, it does not. Neither dry nor moist air acts upon it, and neither cold nor hot water. This is a very useful property. It has been taken advantage of by depositing aluminum on the metal which covers the great tower of the Philadelphia City Hall. It was used there both on account of its lightness and its resistance to oxidation."

"It must be cheap to use in such quantities," said Fritz; "but you say it used to be very dear."

"Yes. Aluminum was first discovered by Wohler in 1828, and in 1846 he obtained it in minute globules. In 1885, the French chemist Deville proved that it could be prepared on a large scale, and since then the process has been so simplified and cheapened that the price of the metal has fallen from thirty dollars a pound to about fifty cents. Sodium was long used in producing it, but the

electric furnace is now employed, and it may be still further cheapened. More than a million pounds are now made annually in this country, and a much larger quantity in Europe."

"Its lightness is a curious and useful property," said Tom.

"Very true. It is much the lightest of the commercial metals. It is lighter than glass and only one-fourth the weight of silver. Gold is nearly eight times as heavy."

"I know that it is used to make small tools and instruments, and also for kitchen utensils," said Fritz. "I suppose it has other uses."

"Yes. It is used for small pipes, and in the manufacture of racing-boats, bicycles, and other things where lightness is of advantage. It is not a strong metal, but may be made hard by hammering and by alloying. The beautiful golden-yellow alloy with copper, known as aluminum bronze, is very hard, and its tensile strength equals that of steel."

"You spoke of sodium. That is a metal, is it not?" asked Tom.

"It is extracted from the alkaline substance named soda. All the alkalies and the earths are really oxides of certain metals. Thus, potash yields potassium, lime yields calcium, and I might name many others, such as lithium, barium, strontium, etc."

"Really, it looks as if the crust of the earth were made up of metals in the grasp of oxygen," said Fritz. "But I am afraid we have more than exhausted your hour, uncle."

"So you have," looking again at his watch. "But no matter; it has been profitably spent."

After dinner was over, Tom and Fritz found their cousin Inez, who felt quite well again, arranging the gems which she proposed to talk about. She had taken from the casket a drawer containing sapphires, which were much admired by her youthful students. After they had handled them all with words of praise, she began her remarks.

"I am glad you find them so attractive," she said. "I consider the sapphire one of the most beautiful of the precious stones, especially when it is of that soft, velvety shade of blue for which fine specimens are noted. Sapphires are, as you may see, very brilliant, and approach closely in value to the diamond. They also come next to it in hardness. They are quite different in composition, however. While the diamond is pure carbon, the sapphire and some other gems are pure alumina. These alumina gems change their name with every change of color. When red they are known as ruby. In fact, the ruby and sapphire are really the same mineral, differing only in color.

"When the alumina takes on a green color, it is known as the oriental emerald; when violet, it is the oriental amethyst; when yellow, the oriental topaz. They are all really sapphires or rubies, though under different names, due to their colors. The asterias or star-stones are also sapphires, the star-like appearance in the stone being caused by the peculiarities of the crystallization. The lapidaries

take advantage of this peculiar appearance, and cut such stones in the shape of a dome (*en cabachon*, it is called). They begin at the centre of the star, and make the points radiate to the circumference. The stone always has six points, and as the light plays on its surface the bright lines of the star change with the position of the gem, and produce a singularly beautiful effect. These stones are very valuable, the best specimens being, it is said, worth as much as diamonds of the same weight.

"Burton, the great Oriental traveller, had a star sapphire which he always carried on his person, and in the heart of Arabia or the deserts of Africa the sight of this wonderful gem always inspired respect that was akin to reverence. The wild Arabs and negroes would gaze at it, then at the possessor, and, concluding that he had a talisman of unexampled power, would render him all possible assistance for fear of incurring his vengeance.

"A perfect sapphire of true corn-flower blue, weighing two or three carats, is valued as highly as a diamond of the same weight, and there is a white or colorless variety, mostly obtained from Ceylon, which is sometimes sold as a diamond. Imperfections are frequent in sapphires,—a purple stone showing almost invariably a silky defect, while those of a green tint display milky spots. The sapphire is often mentioned in the Bible as a gem of surpassing beauty, and tradition asserts that the Ten Commandments were engraved on sapphire.

"The ancients gave the name of sapphire to all

blue stones, though they undoubtedly knew the oriental sapphire. Pliny mentions a blue stone, 'spotted or veined with gold,' which was probably chrysocolla (silicate of copper) or lapis lazuli. Sapphires were said to prevent evil thoughts, and St. Jerome says, 'The sapphire procures favor with princes, pacifies one's enemies, frees from enchantment, and obtains freedom from captivity.' Another superstition was that the sapphire sympathized in color with the health of its owner."

"How very blue they must have felt?" said Tom.

"I wonder if I have any of the sapphire in my disposition?" asked Fritz.

"I have never been able to discover any evidences of preciousness in you," said Tom, "though you do have the faculty of making a fellow feel blue."

Inez held up her finger warningly, to stop this talk in school hours, and resumed her discourse.

"The ancients were undoubtedly acquainted with the oriental sapphire, and it is thus described by Solinus, 'Amongst those things of which we have treated is found also the hyacinthus, of a shining blue color, a stone of price, if it be found without blemish, for it is extremely subject to defects. For generally it is either diluted with violet or clouded with dark shades, or else melts away into a watery hue, with too much whiteness. The best color of the stone is an equable one, neither dulled by too deep a dye, nor too clear with excessive transparency, but which draws a sweetly colored tint from the double mixture of brightness and violet.

This is the gem that feels the influences of the air, and sympathizes with the heavens, and does not shine equally if the sky be cloudy or bright. Besides, when put into the mouth, it is colder than other stones. For engraving upon, indeed, it is by no means adapted, inasmuch as it defies all grinding; it is not, however, entirely invincible, since it is engraved upon and cut into shape by means of the diamond.'

"You will notice that his description of the hyacinthus fits all the tests applied to the oriental sapphire. In the Jardin des Plantes, in Paris, there is on exhibition in the mineral department a sapphire weighing one hundred and thirty-three carats. It is said to be perfect, being quite free from defect. It was formerly in possession of the house of Raspoli, in Rome, and was by them presented to a German prince, who subsequently sold it to a French collector of gems for the sum of thirty-four thousand dollars.

"Two important sapphires were exhibited in London in 1862, and again in Paris, five years later. The largest was of a dark, inky-blue color, and free from imperfections, weighing two hundred and fifty-two carats. The other was smaller but richly colored, and weighed one hundred and sixty-five carats. It is considered one of the finest stones in existence of its size. Its estimated value is between thirty-five thousand and forty thousand dollars The best sapphires are found in the Kingdom of Siam, in the province of Battambong, which supplies more than

half of the world's product. Those found in Burmah are usually tinged with black."

"Are they found in solid rock?" asked Fritz.

"Sometimes. In Siam, however, they are found in clay that contains a little gravel, and which lies under the surface at a depth varying from two to twelve feet."

"It is something like the stuff that holds placer gold," said Fritz. "How do they separate the sapphires from the other matter?"

"In something of the same way," said Inez; "the stones being washed out. The gem-bearing clay is taken to a water-course and carefully washed, the clay flowing off as muddy water. The residue is then spread out and the stones picked out by hand."

"You have mentioned Burmah and Siam. In what other places have they been found?" asked Tom.

"They were discovered in 1880 in Cashmere," rejoined Inez. "Some of these are of fine colors, but the majority are useless as gems from their many defects. It is said that they were originally discovered by a monk, who profited from his discovery by exchanging them for groceries, until he decided to have an idol made from a large piece. The lapidary, who found the stone exceedingly hard, concluded that it must be valuable, and showed it to a government official, who informed the Maharajah of Punjab. The Maharajah sent for the monk and compelled him to disclose the locality."

"I wish you wouldn't keep so far away from home," broke in Fritz. "The United States ought to be good enough to have sapphires of its own."

"So it has," said Inez. "Sapphires were discovered in 1865 on El Dorado Bar, near Helena, Montana; but they were scarcely noticed by the placer miners until a mineralogist in 1873 called attention to their value. After that a few were gathered. In 1883 a company was formed to work exclusively for the gems. Many fine sapphires of the true blue color have been discovered, and also a few rubies. I have here two rows of gems from the Montana fields that have been cut by the lapidary, and here are three rows which are still in the rough or uncut state."

"Well, that is more interesting," said Tom. "When Fritz and I go sapphiring, we won't need to cross the rolling seas. Most of those appear to have a light-blue or light-green hue, and a few are yellow. And here is one that is pink on one end and light blue on the other."

"That is a weakness with the sapphire," said Inez. "They are frequently found having two or more colors; and I remember that one was obtained from Montana of a light-green color which held a ruby in its centre. It was sent to London as a curiosity. But I have told you about all I know about the sapphire. If you are willing, we will turn our attention now to this tray of emeralds, beryls, and aquamarines."

"How beautiful they are!" cried Tom, enthusi-

astically. "I think they surpass the diamonds or rubies in lustre."

"I quite agree with you," said Inez. "The emerald is one of my favorites. There is no combination so pretty in jewelry as that of diamonds and emeralds."

"There is a modesty in such a combination," said Fritz; "but I should prefer diamonds and rubies; they are suggestive of boldness and warmth."

"It is all a matter of taste," said Inez. "I am sorry to say that emeralds appear to be decreasing in number. As late as 1854 my father was in Santa Fé de Bogota, Colombia, and bought there a small yeast-powder can half filled with emeralds in the rough, all badly fractured, for one dollar. I mention this to show you that they were not valued then as highly as they are at present. Ten years later they became favorite jewels, and at that time were worn strung on a thread like pearls or beads. Such a string of emeralds was exhibited in a jeweller's window in Berlin and was estimated to be worth thirty-five hundred dollars. The emerald is one of the most beautiful stones presented to us by nature. Its fine velvety-green appearance is particularly attractive and highly prized. Stones without flaws and of a deep-green color are valued as highly as diamonds. Emeralds of fine color and without flaws are worth, one of four grains, fifty dollars, one of fifteen grains, two hundred and fifty to three hundred dollars, one of twenty-four grains, or six carats, about one thousand dollars. A very perfect speci-

men of six carats has been sold for five thousand dollars. The largest emerald known is the 'Devonshire;' it is two inches in diameter, of the finest color, and perfect. It is in form a natural crystal, and has not yet been placed in the hands of a lapidary."

"How are they prepared?" asked Fritz. "I suppose they occur in nature in a rough state, and need to be cut like diamonds."

"Yes," answered Inez. "I have some rough ones here, as you may see. They are generally cut in the form of a square table with bevelled edges, the lower surface being cut into facets parallel to their sides."

"I see," said Tom. "You have some very handsome illustrations in your cabinet. Do they often come in nature as perfect as these,—only needing cutting to make them fine gems?"

"No; the emerald is rarely without flaws. Its value also depends greatly on its color. A curious circumstance is that emeralds are apt to break after being taken from the matrix. The miners of Muso prevent this by immersing them in lard for a few days, and then in warm water."

"What else is there of interest about them?" asked Fritz. "You have given us the views of ancient writers on other precious stones, what have they to say of the emerald?"

"They had some curious notions," replied Inez. "An ancient writer says that 'Gem engravers are accustomed to refresh their wearied sight by gazing for some minutes upon an emerald kept at hand for

that purpose; it is also considered a specific against epilepsy and a sure cure for dysentery.' Another ancient writer says, 'If the sight hath been wearied and dimmed by intentive poring upon anything else, the beholding of an emerald doth refresh and restore it again.' Psellos, of the eleventh century, speaking of the emerald, says that, 'It is leek-green playing easily into gold and blue, and it has power, when mixed with water, to heal leprosy and other diseases.' One of the ancient superstitions regarding the emerald was that 'it betrays a false witness when in the company of such a one.'

"Isidorus, Bishop of Seville, in 640 A.D., says: 'The emerald in its greenness surpasses all green stones, and even the leaves of plants, and imparts to the air around it a green shimmer; its color is most soothing to the eyes of those engaged in cutting and polishing the stone.' Mr. King, a writer on precious stones, says that a singular property in the emerald, not observed in any other colored stone, is, that if a large, flat one is held so as to reflect the light, it will assume the exact appearance of being silvered on the back; its green disappears when its plane is brought to a certain angle with the ray of light, and it will seem exactly like a fragment of looking-glass in the same position."

"I must say that you have picked up many interesting facts about this beautiful gem," said Fritz. "But you have not yet told us where it is found, or how far back its history goes."

"All in good time," answered Inez. "You

must not expect all things at once. The earliest known emerald mines were those of Egypt. These mines are mentioned by the ancient historians Strabo, Diodorus, and Agatharchides, and were probably worked for many centuries before their time. The stones produced are spoken of as unusually fine gems. Cleopatra presented to ambassadors portraits of herself engraved on these beautiful precious stones, all of which, during her reign, were considered as the property of the crown. Pliny says that the most celebrated mines of emerald in ancient times were in the rocks near Coptos, and that the stones obtained from this region were much admired for their brilliant color. Mohammed Ben Mansur, an Arabian writer of the thirteenth century, says that the emerald mines were located on the border of the land of negroes, but belonged to the kingdom of Egypt. To illustrate the lustre and radiance of the emerald, Pliny says, 'In the island of Cyprus there is placed on the tomb of King Hermios a lion sculptured in marble, and for the eyes emeralds were set in, which shone so brightly on the surrounding sea that the "tunny fish" were frightened away; the fishermen, observing this with dismay, removed the emeralds from the lion, and replaced them by common stones not having so much brilliancy.'"

"Don't you think, Inez, that that sounds very much like a fish story?" asked Fritz.

"Exactly; that was what I told it for—a fish story," she replied. "You are at liberty to believe just as much of it as you please."

"Well, as I happen to have read Pliny, I must say that he is a prime hand at telling tall stories. I am not big enough to believe some of them; it would take two of my size, and then they would need good swallowing powers."

"Please go on, Inez," pleaded Tom. "Don't listen to Fritz's nonsense. He is not worth minding."

"Thank you, Tom; I owe you one for that. And you know that I believe in prompt payment."

"Emeralds have been found in the mines of old Rome and on ancient Egyptian mummies," continued Inez. "The latter fact is held to prove that they were employed as ornamental stones as far back, at least, as the time of Moses. The Bible says that the rainbow is 'like unto an emerald,' and an old Hebrew tradition says that if a serpent fixes its eyes on an emerald it becomes blind. One story is that the Roman emperor Nero was so near-sighted that he used an emerald for an eye-glass to view the combats of the gladiators. It is said also that ornaments of emerald have been excavated from the ruins of Pompeii and Herculaneum. One author states that 'it may be objected that real emeralds are too small to admit of their being used as mirrors,' but the ancients speak of some sufficiently large for that purpose, and also of artificial ones. From this statement we may with certainty conclude that they classed among the emeralds fluor-spar, green vitrified lava, green jasper, and green glass. I might say much also about the use of the emerald in later

ages, but will simply state that Pope Julius II. wore a tiara containing an emerald more than one inch in length and one and a quarter inches in depth."

"So far," said Tom, "it does not seem that America has yielded much in precious stones, though it is so rich in the precious metals. Of course, there are the diamonds of Brazil. I must give America credit for them."

"And you will need to credit it for a splendid output of emeralds, also," said Inez. "Mexico seems to have been rich in this gem. Prescott says of the Mexican emeralds that 'they were found very large, and were fashioned into many curious and fantastic forms.' He also mentions an emerald 'cut into the form of a pyramid of so extraordinary a size that the base was as broad as the palm of the hand.' Emeralds became plentiful in Europe after the discovery of Peru, and Joseph D'Acosta says that on the ship in which he returned to Europe in 1587 there were two chests each containing one hundred weight of these gems.

"The ancient inhabitants of Peru are said to have worshipped an emerald as large as an ostrich egg as their goddess; it was exhibited at great festivals, and the Indians came in multitudes from all parts to see their goddess and present emeralds to her. The priests and chiefs gave the people to understand that the goddess delighted in being presented with her daughters (the emeralds), and by this means they were enabled to collect large quantities of jewels. The Spaniards at the time of their conquest of Peru

found all the 'daughters,' and took possession of them with without ceremony, but the Indians so effectually secreted the goddess (the large emerald) that it has never since been found.

"Since the sixteenth century, Muso, near Santa Fé de Bogota, the capital of Colombia, has been noted for emeralds, and stones that are faultless have always been highly valued. They are found there in a limestone, which is shown by its fossils to belong to the geological period called the cretaceous. As regards the Mexican emeralds, it is said that, for one of the fine stones brought by Cortez on his return to Europe, a Genoese merchant offered him forty thousand ducats,—over ninety thousand dollars of our money."

"What is the composition of emeralds?" asked Tom.

"They are composed of silica, sixty-eight per cent.; alumina, eighteen per cent.; and glucina, fourteen per cent."

"And which of these is the one that gives them their color?" asked Fritz.

"Neither," answered Inez. "The color is said to be due to a very small quantity of oxide of chromium."

"How does the emerald rank in the scale of hardness?" asked Tom.

"Its hardness is about the same as that of the garnet, or seven and five-tenths. But the stone known as the oriental emerald, which, however, is really a green sapphire, comes next to the diamond in hardness."

"Are these two stones emeralds also?" asked Fritz. "You have them side by side with your emeralds, though they are of a beautiful pinkish color. But the emerald may change its color like the other precious stones."

"They are not emeralds," said Inez. "I was handling them before you came in and laid them back in the wrong place. They are called 'Salmon beryls,' which name is given them because they have the color of the flesh of a salmon. You are right in saying that they are beautiful gems."

"Beryls! You have not spoken of them yet. Can you tell us something about them?" said Tom.

"The beryl is almost the same in composition as the emerald and aqua-marine," said Inez. "It differs only in color and in a few minor characters. In fact, the emerald, beryl, and aqua-marine are classed under one head in mineralogy. The coloring matter in the beryl and aqua-marine is iron oxide. The green and blue varieties are called by the jewellers aqua-marine; while the yellow, pink, and other colors are called beryls.

"Streeter says that one of the finest specimens of aqua-marine is the remarkable sword-hilt which was in the collection of Mr. Beresford Hope, exhibited for some years in the South Kensington Museum. It is beautiful in color and perfectly pure, is cut into numerous facets, and is unique both as a mineral and as an example of the lapidary's art. This magnificent stone, which is said to have belonged to Prince Murat, weighs three and a half ounces. In

the same collection was an aqua-marine engraved to represent a female holding a bagpipe, a light drapery floating around the upper part of the body. A necklace of great beauty composed of salmon beryls and aqua-marines is worn by a wealthy New York lady, who purchased it in London."

"Where are the beryl and the aqua-marine found?" asked Tom.

"They have been obtained in many localities, though the finest stones come from Brazil. Gems of beryl and aqua-marine are also found on Mount Antero, in Colorado. These stones are great favorites in England because they retain their lustre and brilliancy in artificial light. But isn't that Harry calling? and does he not say something about supper?"

"Why, it does sound like it," said Tom. "It seems to me that the supper-hour has followed dinner very closely. Why can't we do without eating when we have so much better matters on hand?"

"You can, if you wish," said Fritz. "Inez and I will go to supper, and leave you here lost in admiration. Not that I am tired, Inez. I do not think I could get tired of the feast you have given us, but——"

"But supper has its claims, too," she said, laughingly. "I thank you for your compliments, and must say that it is a pleasure to have two such attentive listeners. I have tried my gems on Harry, but cannot get him interested in them. He makes too much of a hobby of his precious minerals to waste much of his valuable time on my precious stones."

"That shows his lack of taste," said Fritz. "But it is easy to explain. If it was somebody else's sister instead of his own, Harry's love of gems might suddenly develop."

"There's Harry's musical voice again," said Tom. "We had better obey, or he will be after us in person."

"Not he, when supper is on the table," said Fritz. "Our friend Harry is too level-headed for that."

"His taste does not run for precious stones at any time, and certainly not at supper-time," said Inez. "But I think we had better obey his summons."

"Lead on, Inez; trust us to follow," answered Tom.

CHAPTER XII.

MERCURY, PLATINUM, AND ROYAL CROWNS.

THE next morning, while Uncle Ben was lounging in his easy-chair in the library, enjoying a fragrant Havana, Tom and Fritz entered rubbing their hands vigorously.

"Good-morning, Uncle Ben," cried Fritz.

"Good-morning, boys. What's the matter? Are you cold?"

"Yes. We went out for a walk after breakfast, but found the air so keen and cold that we did not go far. The thermometer shows a temperature not far above freezing," said Tom.

"Talking of the thermometer," said Fritz, "I am reminded that I have always been curious about the strange metal, mercury or quicksilver, which is used in it. If you are not otherwise engaged, uncle, I should be pleased to have you tell us something about it, and I think Tom would also."

"Certainly; if you will let me smoke and talk at once. Quicksilver is one of the most useful of the metals, largely from its valuable property of being a liquid at ordinary temperatures. It is employed in many operations in the arts and sciences. One of its common uses, as you have just observed, is in the thermometer. Its density, and its regularity of ex-

pansion and contraction by the increase or diminution of temperature, give it a preference over all other liquids for that purpose. One of the most important applications of quicksilver is in the extraction of gold and silver from the gravel and rocks of our mines. This process is called amalgamation, which means the adhesion of the particles of metal to the mercury, with which they form a pasty mass, while the earthy portions flow off. The mixture is called amalgam."

"I think Harry told us something about that the day we were at Cherry Creek," said Tom. "But he did not tell how the quicksilver was induced to let go of the precious metals."

"That is not difficult. The amalgam is first put into a buckskin bag and squeezed, the result being that a large portion of the quicksilver oozes through the bag. The remaining portion, which contains the metal to be saved, is placed in an iron retort and a brisk fire built under it. The heat vaporizes the mercury and drives it through the retort pipe, the nozzle of which is let into a tub of water, so that the mercury is chilled and condensed again. When it ceases to run from the pipe, the gold or silver will be found in a free state in the retort.

"Formerly, metals were gilded by applying gold amalgam, and subsequently driving the mercury off by fire; but the process was attended with dangerous consequences to the health of the workmen, from the poisonous mercurial vapors, and has therefore been abandoned. The gilding of metals is now

effected by electricity. Also for the bright, useful mirrors that adorn our dwellings we are indebted to quicksilver, since their reflecting properties are due to an amalgam of mercury and tin."

"How is it applied to the glass?" asked Fritz.

"Very easily," answered Uncle Ben. "A thin sheet of tin is laid upon a marble table and quicksilver is poured over it. The glass is then laid upon it, and heavy weights are placed on the glass to squeeze out the excess of mercury. The table is given a slight incline, so that the mercury may run off. After a lapse of several days the glass plate is removed, and is found covered with amalgam, which adheres closely to its surface. Mercury also readily unites with zinc, and is rubbed on the plates of that metal in voltaic batteries to protect them from the action of the acids in which they are immersed. It is the basis of many medicines, and is indispensable in the construction of surgical and philosophical instruments.

"Mercury freezes into a malleable mass at 40°, Fahrenheit, below zero, and boils at about 660° above zero. When frozen it crystallizes into regular octahedrons. In that state it can be beaten into leaves as thin as paper. This has been done at Hudson's Bay, where it is at times cold enough to freeze mercury. The anvil and hammer were, of course, reduced to the same low temperature. When some of this solid mercury was plunged into a glass of warm water it quickly became fluid, and the water froze so rapidly that the glass was shivered

into atoms. To return to the subject of amalgam, a native amalgam of silver and mercury is usually found where a vein of silver and one of mercury intersect."

"Nature seems to do everything that man does," said Tom. "I should like to see some of nature's amalgamation. Have you a specimen of it in your collection?"

"Yes, here is one. Its composition is twenty-seven per cent. silver and seventy-three per cent. mercury. This specimen was presented to me by a friend who brought it from Kongsberg, Norway."

"Well, who would suppose that the volatile quicksilver was imprisoned in that solid lump," said Fritz. "It seems to be quite hard; even harder than lead."

"Considerably harder, I should say. Lead is only one and a half on the scale of hardness, while this native amalgam is three and a half. When rubbed on copper it leaves a white mark. If I should expose this to the blow-pipe, the mercury would volatilize and a button of pure silver would be left."

"How does mercury occur?" asked Tom. "Is it found in the liquid state, or are there solid ores? Of course there is, though; for this silver amalgam is an ore of mercury."

"Just so," said Uncle Ben; "either of silver or mercury, whichever you are seeking. The principal ore of mercury is known as cinnabar. It is a red mineral of various shades. Here is a specimen from the new Almaden mines of California. In composition it is a protosulphide of mercury, containing

about eighty-six per cent. of mercury and fourteen of sulphur. From cinnabar the most of the mercury of commerce is obtained. When pure, it is the vermilion of commerce, and is used largely in painting. Fused with rosin it makes red sealing-wax. Vermilion may be made artificially by fusing sulphur with six times its weight of mercury.

"When perfectly fluid, quicksilver feels very cold, but does not adhere to the fingers. It has neither taste nor smell, and is of a silver-white color. After platinum and gold, it is the heaviest of metals. You asked if it is found in the liquid or native state. I may answer yes, but very rarely. In California it is found in the vicinity of extinct hot springs, and in the Pioneer Mine, Napa Valley, California, quartz geodes have been found nearly filled with pure mercury.

"The quicksilver mines of Almaden, in Spain, are of great antiquity. It is found there as cinnabar. Seven hundred years before the birth of Christ the Greeks imported the metal from that locality, and Rome in the time of Pliny received three hundred and fifty tons annually from the same source. At the present day the mines yield more than a thousand tons annually. The quicksilver mines of New Almaden, in the Santa Clara Valley, California, have about the same annual yield. There are many other smaller mines of quicksilver in California and a few in Oregon, and it is also abundant in Tuscany, China, and Mexico.

"Quicksilver is so elastic as a vapor that it is

capable of bursting the strongest vessels. A very pretty experiment with it is called the 'silver tree,' and is made in this manner. Place in a small vial about fifty cents' worth of nitrate of silver, and fill the bottle with distilled or rain water. When the nitrate of silver is dissolved, place in the bottle about half a teaspoonful of quicksilver; it will immediately be attacked by the nitrate of silver in solution, and grow under your eyes into beautiful arborescent forms,—veritable silver trees. It should be moved with care, as it is very fragile."

"I am glad to know that," said Tom. "The experiment seems so easy that I shall make one as soon as I return home."

"We certainly owe you thanks, Uncle Ben, for this information about mercury, and, if you will let us trespass further on your time, I should be glad to learn something about platinum. I think Tom would also, as he was talking about it this morning."

"It is not a very extensive subject," said Uncle Ben. "At any rate, it will not take very long for me to tell you all I know about platinum. It was first found in America in the gravel of the river Pinto, near Popayan, Colombia, and was brought to this country by Juan Ulloa, a Spanish gentleman in the year 1735; but its most important localities in America are in certain alluvial districts of Mexico and Brazil. California also yields it. It is usually found as small, flat scales, though it is not unusual to find nuggets.

"Platinum is malleable and ductile, and when

pure is the heaviest of all metals except iridium, its gravity being over twenty-two, while that of iridium is nearly twenty-three. Before the blow-pipe it is infusible. It does not oxidize in the air at any temperature, and is not attacked by any single acid. Its great infusibility and resistance to ordinary chemical agents render it of the highest value to manufacturing and experimental chemists. It is used in Russia as a coin. It easily alloys with other metals, and is never found pure, being associated with such rare metals as osmium, rhodium, iridium, and palladium. It is also associated with gold, copper, and iron."

"If it is infusible before the blow-pipe, how can you make a test for it?" asked Tom.

"It is tested in the following manner: The platinum is dissolved in aqua regia,—a mixture of two parts muriatic acid and one part nitric acid,—using a gentle heat. When dissolved, we add a solution of protochloride of tin. If platinum is present, a dark brownish-red color will now be perceived, though there is no precipitate.

"The principal supply of platinum has long come from the Russian mines in the Ural mountains, and is chiefly refined in England. A few years since it was largely used in jewelry, which is still the case to some extent, though when used for that purpose it is always alloyed with silver."

"Is that all?" asked Tom, as Uncle Ben ceased speaking.

"I told you it was a short story," he replied. "I might have said something about its use in electrical

experiments, in which its resistance to heat and corrosion is a valuable property. Its great resistance to fusion is its most valuable quality."

"Yes; I have heard of its being used for making crucibles and retorts," said Fritz. "I suppose on account of the fact that a hot fire will not melt it."

"Harry, Inez, and I are going to the mine tomorrow," said Uncle Ben. "We will leave Eva to take care of you. I think she can give you a genuine treat by exhibiting the sketches taken while on her travels abroad. She is also able to tell you all about the crown jewels of Europe. Jessie and Estelle have promised to spend the day with her. Perhaps, though, you would rather go with us to the mountains?"

"It is a choice between pleasures," said Tom. "The attraction to stay at home is great; and so is that to go abroad. Perhaps we had better divide forces,—I staying at home to look after the girls, and Fritz going with you to the hills."

"You are a clever hand at arranging matters, Master Tom," said Fritz. "I can't say that I am in the humor for travelling, and we have not had a lesson yet from Eva."

"And have not seen much of Jessie and Estelle," said Uncle Ben, slyly. "Very well, boys; let it be so. I was young once myself, and can appreciate your taste for sketches."

On the following morning, Aunt Lida, accompanied by Eva, Tom, and Fritz, went to the station to see the remainder of the household party off on the

train. On returning to the house, Eva invited her cousins into the library. Jessie and Estelle had called during their absence and awaited them there, and a lively greeting followed. After a period devoted to gay chat, Eva produced her portfolio of sketches and prepared for the more serious business of the morning.

"I do not need to tell you," she began, "that we all have our hobbies in this house. Papa and Harry are daft on the subject of minerals. Inez dreams at night of jewels, and I am, I suppose, as far gone as any of them on my hobby of sketching. I have made sketches of the royal crowns of Europe, so far as I could get the opportunity, and that is what I am here to talk about to-day."

"And we to listen to," said her girl friends.

"We will content ourselves with looking at——" began Fritz.

"At what?" interrupted Tom.

"Oh, at the sketches. I would not for worlds let my eyes wander in any other direction."

"See that you don't," said Eva, shaking her finger at him. "I am here for serious business, and any frivolity will be followed by an edict of banishment."

"All right," said Fritz; "you can count on us as saints."

"I promise to act as detective, to discover any stolen glances by our saint," said Jessie, with a merry look at Fritz.

"You must not expect to learn as much from my talk as from your sessions with Inez," said Eva; "but

I will endeavor to make it interesting, at any rate. Here is a sketch of eight crowns which I saw at the Cluny Museum in Paris. They were discovered by grave-diggers while excavating in a cemetery near Toledo, Spain. Four of the crowns are of gold and are richly jewelled, and crosses composed of jewels are suspended by gold chains in front of them. The largest of these crowns has the inscription, 'Reccesvinthus rex offeret' ('offered by Reccesvinthus the king'). This inscription is in letters of gold about two inches long, each of which contains jewels, while each letter is separate, they being hung around the crown with small golden chains. Pendant from each letter is a pearl and a sapphire. The king who wore this crown governed Spain from A.D. 653 to 675. The crown measures nine inches in diameter and twenty-seven inches in circumference. All of these crowns are richly set in gems, and their discovery is considered the most interesting of the kind in modern times."

"I should think so, indeed!" cried Jessie. "Where were all the successors of this king with the long name, that they did not turn his gold into coin and his gems into jewels for themselves?"

"That was what I thought," said Estelle. "Those were not the days of conscientious kings."

"I doubt if there are many of that kind of kings even to-day," said Fritz.

"How they escaped is more than I know," said Eva; "but there they are in all their pride and glory. The badge of royalty for the Saxon mon-

archs was a diadem of pearls. It may be seen on the coins of Athelstan. Among the jewels found in Westminster Abbey in 1649 was one which was called 'King Alfred's Crowne.' This is described as made from gold wire work, set with jewels and two bells. We are told that Alfred's crown weighed over six and a half pounds,—probably a different one from that just named. A radiated cap appears first on a coin of Ethelred II., and the trefoil ornament on the crown of Canute, the Danish king of England. The crown of Henry I. was open and round, and had appendages on each side to fasten under the chin. That of Richard I. was richly set in jewels. King John is said to have had several crowns, but he had the ill luck to lose them while crossing a river in 1216.

"The crown worn by Edward VI. was discovered in an iron chest in 1649. The jewels with which it was adorned were the following: one large diamond (valued at one thousand dollars), thirteen smaller diamonds, ten rubies, one emerald, one sapphire, and seventy pearls. During the reign of James I. there was made a list of crowns worn by royalty before his time. This includes a description of the crown of England as it was at that time. The statement says: 'It was set about the lower border with nineteen great pointed diamonds, and between each a knot of pearls. In the upper border were eight large rubies and twenty pearls. Each of the four arches was set with a table ruby, a table diamond, and an emerald; two of the arches contained eigh-

teen pearls, the other two seventeen pearls. Between each arch was a large pink ruby, the whole being surmounted by a blue enamelled gold cross. The crown of Charles I. contained twenty-eight diamonds, three hundred and eighty sapphires and rubies, two emeralds, two hundred and thirty-two pearls, and twenty-one pink rubies. The weight of the gold was seven pounds seven ounces."

"Is there not a story about an attempt to steal this crown?" asked Estelle. "You told me once something of the kind."

"Not this, but that of Charles II.," answered Eva. "This daring attempt was made May 9, 1671, by a man named Thomas Blood, a lieutenant in Cromwell's army. Blood was a native of Ireland, whose desperate character is shown by several plots in which he took part. He was one of the ringleaders, at the time of the restoration of Charles II., in the attempt to surprise Dublin Castle and capture the Duke of Ormond, then lord lieutenant. The plot was unsuccessful, but Blood escaped. Some years afterwards he waylaid the Duke of Ormond in England, captured him, and tied him on a horse, intending to hang him on Tyburn tree. Some of the duke's servants arrived just in time to save him. In this transaction Blood was disguised, and was not recognized nor captured, though a reward of five thousand dollars was offered for the perpetrator.

"About three weeks before his attempt to steal the crown he visited the Tower, disguised as a clergyman, accompanied by his wife. The lady re-

quested to see the crown. After viewing it she feigned illness, but soon recovered and left, with many thanks to the keeper and his wife. After a lapse of a week Blood returned and presented the keeper's wife with four pairs of gloves,—'a present from his wife,' he said. During the conversation Blood proposed the marriage of the keeper's daughter to his nephew. The offer was favorably received, and a day was appointed for the young couple to meet. On this day Blood returned with three companions and requested that the keeper show them the crown jewels, a request with which the old keeper, who had no thought of suspicion, readily complied. But the confederates were no sooner in the room where the crown was kept than they threw a cloak over the keeper's head and put a wooden gag in his mouth. As the old man continued to make a noise, they pounded him on the head with a wooden mallet until he was unconscious, and then made off with the crown and orb, leaving the jewelled sceptre behind. After a long chase the thieves were captured and the crown restored."

"I fancy Blood did not get off so easily this time," said Tom. "That must have been a hanging matter."

"Not at all. He was kept a short time in prison and then pardoned by the king, who afterwards gave him a pension."

"What for?" exclaimed Jessie.

"That is more than I can say. Perhaps Charles thought he might be useful in hanging some more

dukes. The coronet of the Prince of Wales," she continued, "is a gold circle with crosses and fleurs-de-lis, but it has only one arch."

"Fleur-de-lis! I beg pardon for ignorance, but what is that, Eva?" asked Jessie.

"The fleur-de-lis is the flower of the water-lily, or yellow flag," she replied. "It was the principal feature of the armorial bearings of French kings before Louis XVI. But, to go back to an earlier age, I have here a sketch of the crown worn by Charlemagne. I made this when I visited the Imperial Library in Vienna. The crown, which is of pure gold and weighs fourteen pounds, is divided into eight compartments. The first division has twelve unpolished jewels; the second contains a figure of our Saviour sitting between two cherubs; the third, fifth, and seventh compartments contain gold and gems; in the fourth is the figure of King Hezekiah and the prophet Isaiah; the sixth has a figure of King David crowned; the eighth contains a figure of King Solomon. You will notice in the sketch that the top of the crown is a cross of gold in which there are seventeen jewels."

"There seems to be an inscription on top of the cross," said Estelle.

"Yes; it reads as follows: 'I. H. S., Rex Judæorum.' The crown is beautifully enamelled. In A.D. 1160 this crown was stolen by Frederick Barbarossa from the sepulchre of the king, and it has been used at the coronation of the German emperors. Next in my list comes this sketch of the crown of Hungary.

It is the one which was used at the coronation of the present emperor of Austria, though it is of old date. An old superstition is that it fell from heaven for St. Stephen. It is a flat band of gold surmounted by a cross and is richly enamelled. The edge of the crown or upper border is formed of pearls ; there is a large sapphire in the back, four smaller sapphires in front, and a large heart-shaped amethyst."

"This sketch, I see, is of the iron crown of Italy," said Tom, taking up the next in order.

"Yes. It is made of gold set with rubies, emeralds, and sapphires. It is a broad, enamelled band."

"But why is it called the iron crown, when made of gold?" asked Fritz.

"Because there is attached to the inner circle of the crown a narrow band of iron about three-eighths of an inch broad and one-tenth of an inch in thickness. It is said to have been made from one of the nails used at the crucifixion, which was given by the Empress Helena (who is credited by tradition with having discovered the cross on which Christ suffered) to her son Constantine as a protection from the dangers of war. The priests point out as a miracle that there is no rust upon the iron, although it has been exposed for more than fifteen hundred years."

"That is a curious story," said Tom. "Are there many that believe it?"

"Very probably ; though I am not one of them."

"Oh, dear! You ought to believe what you are told," cried Fritz.

"Do you, Master Fritz?"

"Oh, I am an exception," declared Fritz. "I am not to be counted in."

"The first notice of the iron crown," said Eva, after a laugh at Fritz, "is that it was used to crown Agilulfus, king of Normandy, in A.D. 591. Here is a sketch of the Russian crown. This, with the other state jewels, is valued at the enormous sum of eleven millions of dollars, the crown itself being worth six millions of dollars. It is adorned with hundreds of diamonds. Besides the diamonds, which make the crown look as if it had been buried in a shower of falling stars, there are fifty-four pearls (each without a flaw) set around the rim, while a ruby of extraordinary size and brilliancy is used as a centre piece. The crown was made by a jeweller from Genoa, and was first used by Catherine the Great. It is kept in the Imperial treasury in the Kremlin at Moscow."

"What is the Kremlin, Eva?" asked Estelle.

"The Kremlin is the ancient palace of Russia, the residence of the czars before the capital was removed to St. Petersburg by Peter the Great. The vaults of the Kremlin are rich in royal regalia. In one department there is a collection of relics such as were worn by the different emperors and czars, laden with precious stones. The crown of Prince Vladimir is rich with pearls and other gems, and has a Greek cross for a top piece. The crown of Cazan is also there, as well as the crowns of Astrakhan and Siberia. The crown of John Alexius has eight

hundred and eighty-one diamonds and one immense dazzling ruby. That of Peter the Great is set with eight hundred and forty-seven diamonds. The crown of Catherine I. has two thousand five hundred and thirty-six diamonds of the first water. When Anne became empress, she added to the crown a ruby of enormous size, which was brought to her from Peking by the Russian ambassador.

"The crown worn by Victoria, queen of England, excels all others for beauty of design and brilliancy. It was made in 1838 with jewels taken from old crowns, and others furnished by command of the queen. It consists of diamonds, pearls, rubies, sapphires, and emeralds set in gold and silver, has a crimson velvet cap with ermine border, and is lined with white silk. Its weight is thirty-nine ounces five pennyweights. The lower part of the band above the ermine border consists of a row of one hundred and twenty-nine pearls, and the upper part of the band of a row of one hundred and twelve pearls, between which, in front of the crown, is a large sapphire, which was purchased for the crown of George the Fourth. At the back is a sapphire of smaller size and six still smaller (three on each side), between which are eight emeralds. Above and below the several sapphires are fourteen diamonds, and around the eight emeralds are one hundred and twenty-eight diamonds. Between the emeralds and sapphires are sixteen trefoil ornaments, composed of one hundred and sixteen diamonds. Above the band are eight sapphires surmounted by

eight diamonds, between which are eight festoons consisting of one hundred and forty-eight diamonds.

"In the front of the crown, and in the centre of a diamond Maltese cross, is the famous ruby said to have been given to Edward, Prince of Wales, by Don Pedro, King of Castile, in 1367. Around this ruby seventy-five brilliant diamonds are disposed to form the cross. Three other Maltese crosses, forming the two sides and the back of the crown, have emerald centres, and contain respectively one hundred and thirty-two, one hundred and twenty-four, and one hundred and thirty diamonds. Between the four Maltese crosses are four ornaments in the form of the French fleur-de-lis, with four rubies in the centre, which are surrounded by rose-cut diamonds, three hundred and forty-four in all. Rising from the Maltese crosses are four imperial arches composed of oak leaves and acorns, the leaves containing seven hundred and twenty-eight diamonds. Twenty-two pearls form the acorns, which are set in cups containing fifty-four rose-cut diamonds, and one table diamond. The total number of diamonds in the arches and acorns is one hundred and eight brilliants, one hundred and sixteen table cut, and five hundred and fifty-nine rose cut.

"From the upper part of the arches are suspended four large pear-shaped pearls, with diamond caps and stems, containing twenty-four very small diamonds. Above the arch stands the mound, containing in the lower hemisphere three hundred and four brilliants, and in the upper two hundred

and forty-four brilliants. The zone and arc are composed of thirty-three rose-cut diamonds. The cross on the summit has a rose-cut sapphire in the centre, surrounded by four large brilliants and one hundred and eight small diamonds. The crown contains in all two thousand eight hundred and sixteen precious stones and two hundred and seventy-seven pearls.

"I declare, mamma is already calling us to lunch!" cried Eva, interrupting her narration. "Can it be so late? I was about to tell you something about my travels among the ancient ruins of Italy and Egypt."

"That will come in nicely after lunch," said Jessie. "And, Eva, don't forget to add the story of what you saw in Florence, Italy. I mean about the mosaic work."

"As you please. But we had better now adjourn to the dining-room."

CHAPTER XIII.

A TALK ABOUT THE TOMBS.

AFTER having taken their lunch in Mrs. White's hospitable dining-room, the party of young people returned to the library, where Eva opened her portfolio of sketches, taking from it copies of some fine examples of mosaic work which she had seen in Florence. They were drawn in the original colors, and were passed from hand to hand with looks and words of admiration.

"They excel in this kind of work in Florence," she said. "I was kindly permitted to make copies by the superintendent; but I can assure you it was tedious work. I would rather paint a dozen landscapes than attempt to copy another of those mosaic squares. The place where they are made is called the 'pietra dura' factory."

"Pietra dura! What is meant by that?" asked Fritz.

"It means 'hard stone,' and refers to the character of the materials used. We were taken into a large gallery, around which were cabinets filled with agate, jasper, chalcedony, black onyx, carnelian, and other fine stones employed in the work. The stones are cut to the required shapes by the aid of a wire and emery powder, and, when polished, are carefully

set in the places allotted to them. So tedious is the work that a small piece of inlaying, about two inches square, shown me by one of the men, had taken him two months to accomplish. The artists are principally employed in works for the Medici Chapel, an edifice begun by Ferdinand I. in 1604 and not yet finished."

"Nearly three centuries, and not done yet!" cried Estelle. "It ought to be very magnificent."

"It certainly is," rejoined Eva. "It is lined with all the richest varieties of jaspers, marbles, and various other ornamental stones. Its form is octagonal, six of the sides being ornamented with magnificent sarcophagi of Egyptian granite. The bodies lie in a repository beneath, but the sarcophagi are inscribed to the memory of the first six reigning dukes of the Medici family. The chapel is still further adorned with the armorial bearings of sixteen Tuscan cities, exquisitely executed in lapis lazuli, oriental alabaster, mother-of-pearl, and many precious stones. The grandeur of this chapel forms a singular contrast to the simplicity of the tomb of the great founder of the family. He is buried in the church of St. Lorenzo, where a pavement of porphyry, serpentine, and marble covers the tomb, on which is inscribed, 'Here lies Cosmo de Medici, surnamed by a public decree the Father of his Country. He lived 75 years 3 months and 20 days.'"

"And he lived to some effect, too," said Jessie, "if one may judge from the historical accounts of his career. You see, I know something of Italian

history, if I know little of mosaic. It seems to me, though, that I have heard of Roman mosaic. How does it differ from the Florentine?"

"It is composed entirely of glass of varied colors," said Eva. "The principal manufactory, which we did not fail to visit, is in the Vatican, the palace of the pope, which, as you probably know, is a great museum of all kinds of art products. The patience required in making this mosaic is unbounded. The number of shades of glass which are employed amount to more than eighteen thousand, and by means of these the coloring of a painting can be imitated with the greatest accuracy. This establishment in the Vatican is solely employed in copying paintings for the decoration of St. Peter's Cathedral."

"The work must be frightfully tedious," said Jessie. "Just think of the labor of selecting from so many shades of color! I pity the poor eyes of the workmen. And after all, these mosaics must be very inferior to paintings."

"Very true," said Eva. "Compared with paintings they must always hold an inferior rank in art. But mosaic possesses the advantage of being uninjured by damp, the fading of colors, and all the various causes by which painting is depreciated or destroyed. If you could see the magnificent copies in mosaic of the old masters which decorate St. Peter's, you could not but value an art by which so many fine works are perpetuated, which in the original are gradually losing their beauty, and, but for

these imperishable copies, would be lost to the ages to come."

"Did you visit any of the ancient sepulchres?" asked Tom.

"Yes. I think I had a passion for looking up odd and curious places. I wished to fill my portfolios, you see. Here is a sketch of a Greek tomb at Pæstum. It is an exact copy."

"And a very curious place," said Jessie, looking at the sketch with much interest. "The walls appear to be painted, and the place to be adorned with armor and vases. There is a skeleton, too, which I hardly consider an adornment. What is it doing here? I thought that the ancients burned their dead."

"Not always," said Eva. "They sometimes adopted one mode, sometimes the other. Interment was the more ancient practice. The bodies of infants, and of those who were killed by lightning, were forbidden by law to be burned. Hercules is said to have been the first who introduced the custom of burning the dead. Having promised to bring back Argæus, one of the victims of the Trojan war, to his father, and being unable to restore him alive, Hercules burnt his body, and carried back the ashes in order not to fail in his engagement to the father. That, at least, is the tradition by which the Greeks account for the origin of the practice. It is probably as doubtful as all that is told about Hercules and the Trojan war."

"Then there was no regular rule observed with

regard to the interment of the dead," remarked Fritz.

"There does not seem to have been," said Eva. "The people seem to have been free either to burn or bury the bodies of their dead. The Greeks used to conceal their tombs, which they placed on the north side of their towns. The Romans, on the contrary, liked to exhibit their sepulchres in public situations, as along the roads, where numberless tombs and sarcophagi show their taste for monumental grandeur.

"But their private tombs were of a different description. These were placed underground, and consisted of tiers of small niches, each of which held one or more urns. Here the master and the slave were buried together, and all that lived in one family shared the same cemetery. This kind of vault was called a columbarium, from its resemblance to the holes in which pigeons build their nests.

"The tombs vary in their forms and structure. Some are dug in the tufa or rock, others are built of stone and brick in the form of a room or chamber. Sometimes the bodies were burned and the ashes placed in an urn and buried in the ground, the only protection being a square stone laid over the urn. Such an urn, made of porphyry, was discovered at Cuma, and to this mode of interment we are indebted for one of the finest painted vases in the museum at Naples. This, which is called, from the subject depicted upon it, 'The last night of Troy,' is unrivalled for the beauty of its form and design, its state of

preservation, and the fineness of its varnish. It was found in 1797 at Nola, a place celebrated for its fine vases, and had been enclosed in an outer vase of coarse earthenware in order to protect it. It was full of human ashes, and had been simply buried in the ground without any kind of tomb."

"It is strange that so beautiful a work of art should not have been enclosed in some grand monument," said Tom, "for it must have held the ashes of some person of high importance. Did the ancients have any particular form for these burial urns?"

"Cinerary urns, they are called," said Eva, "from the Latin word for ashes. There seems to have been great latitude in regard to shape. They are found with two or three handles, and even simple plates have been discovered containing ashes and burnt bones."

"This sketch of a tomb shows it to have been full of curiosities," said Jessie.

"That is why I sketched that particular tomb," rejoined Eva; "but the contents of the tombs vary according to the condition of the person interred. Those of the rich are full of objects of interest, and present a curious insight into the domestic life of the ancients. In the centre of the large apartment is laid the body, with an incense bottle on the breast, or, as they are termed, lachrymatories, or tear vessels."

"Why are they given so curious a name?" asked Estelle.

"The name was long held to indicate that their purpose was to hold the tears of the relatives," said Eva. 'But they were really so named because, from the form of the neck of the bottle, the perfume fell from it drop by drop as tears flow from the eye. Sometimes there are several of these incense bottles around the body, made either of glass, alabaster, or earthenware. It appears that these bottles were carried by the relatives to the grave, when the perfumes they contained were poured over the body and the bottles deposited in the tomb."

"What else do the sepulchres contain?" asked Fritz.

"One very curious offering is a morsel of food for Cerberus, the three-headed dog that was believed to guard the gates of Hades. This was placed on a dish, that it might aid the spirit of the deceased in passing this terrible sentinel. A number of vases were also arranged about the tomb, some standing, and others hung on the wall. Some men were buried in their armor, others with tablets to write upon, or some object which suggested their profession. In the tombs of women are found mirrors, rouge, combs, ornaments for the hair, etc., and dolls and playthings in those of children."

"Of what were the mirrors made?" asked Jessie. "Of glass backed with quicksilver, like ours?"

"The ancient mirrors were mostly of bronze," answered Eva; "but Pliny speaks of some made of green glass. The Roman ladies always carried their mirrors with them; and it appears that they were

acquainted with all the deceptions of the modern toilet. They wore false hair, false teeth, false eyebrows and eyelashes, and some of them, I fancy, false hearts. They painted and powdered their lips and faces, and sometimes dyed their hair. The tombs contain many other articles than those I have named, such as amber, gold, silver, iron, copper, mother-of-pearl, glass, and quartz crystals. There were also placed in them several kinds of food, such as eggs, shell-fish, wine, and bones of birds."

"In what state are these sepulchres generally found?" asked Tom.

"Some have no earth whatever in them," answered Eva, "except the small quantity which the relatives sprinkled over the body at the time of interment; others are quite filled up with mould. This is due either to the roof having given way or to the excavations of the Romans, who opened the Italo-Greek tombs for the painted vases which they contained, and which, even at that period, were valued for their beauty and antiquity."

"Were they so very beautiful?" asked Jessie. "How were they painted? And, if I may ask, what do you mean by the Italo-Greeks?"

"The inhabitants of the cities which were founded by Greeks in southern Italy. They brought with them the art of Greece, which was far in advance of that of the early Romans. The Italo-Greek vases were all of fine red pottery varnished; and the figures upon them are either painted in black upon the natural red ground of the vase, or the vase is ground

in black and the figures left red, the draperies and features being traced out in black. Of these two kinds of vases the first is the most esteemed; as far as can be inferred from minute examination, it was executed in this manner. After the vase had been once placed in the fire, the figures were lightly shaded out with a brush that had been dipped into a thinly diluted mixture of the black varnish. The simple figures appear to have been first sketched and the draperies afterwards added. The figures were next filled up with black, the contours corrected and finished off with fine sharp lines of black varnish, and the drapery, the features, and the details which occur inside the black figure were picked out with a sharp instrument. The vase was then returned to the oven, where the action of heat completed the process."

"Are all the Roman vases which one sees in museums genuine?" asked Jessie. "As imitation of the art work of the ancients is so active a modern industry, I fancy the contents of the grave can hardly have escaped."

"You are quite correct in that," said Eva. "To use an old proverb, 'all is grist that comes to the mill' of the imitators. But the modern imitations may be easily detected by immersing the vase in alcohol, when the colors speedily disappear; whereas the ancient vases have the colors burnt in and are unaffected by this test."

"I believe that in addition to the Greek and Roman tombs of Italy," said Fritz, "there are others belonging to the more ancient people known as

the Etruscans. I suppose you called on some of these old folks in their final dwelling-places."

"I could not in justice neglect them," said Eva. "I found them resting in tombs built in the solid rock, and well provided with contents which are of much use in affording us information about their customs. These contents include vases, arms, ornaments of gold, and other objects; and the rock in which the tombs are excavated proved so favorable to the preservation of the body, when the air was excluded, that a person who looked through the first opening into the tomb made by the workmen saw a body stretched on a bench with its garments in perfect preservation. But, from the admission of air, it sank down while he was looking at it, leaving only a picture in dust of the human form that had once been there. These tombs have given us much information concerning the art of the Etruscans, who were celebrated for their engraving on stones as also for their work in terra-cotta, brass, gold, and other substances."

"Did they use money?" asked Fritz. "They might have used it, it is true, without burying it with the dead; but has any been found?"

"No Etruscan silver coins are known, and very few circular coins have been found. Plutarch says that their money was in rods of iron, brass, etc., cut off at various lengths and marked VI., XII., etc., according to the length of the pieces."

"Excuse me, Eva, for indulging in a compliment," said Tom, "but I must say that you and Inez believe in going through the world with your eyes open."

"I will second your compliment," said Fritz. "They see all there is worth seeing. And it is certainly an excellent idea to make notes and sketches for future reference. I am very proud of both of them."

"Many thanks," said Eva, with a low bow. "Your compliments are highly appreciated. I shall have to get a copy engrossed on tinted paper and present it to Inez. Mine is already deeply engraved upon memory. But as the information which has interested you so highly has put Jessie nearly to sleep and Estelle quite so, I propose a walk in the fresh air as an escape from the air of the tombs."

"Asleep! you sinner!" cried Jessie, "and after my intelligent questions. 'That is the most unkindest cut of all,' as Shakespeare remarks. For me, that is. As for Estelle, who is sound asleep behind the portière——"

"Now, Jessie, how can you say such a thing?" exclaimed Estelle, rubbing her eyes in a dazed manner that made them all laugh. "If I have not asked many questions, it is because none of you gave me a chance."

"Oh, come, Estelle," broke in Eva; "you are not going to pay any attention to this ill-natured critic, I hope. All that ails her is that she has not had so comfortable a time as yourself. I know you were listening intently. But, as I can see cobwebs in the eyes of these others, especially Tom and Fritz, I think we had better leave the tombs for awhile. If

you don't mind, I will take you after supper on a stroll through those of ancient Egypt."

"We had better go somewhere, or there will be murder done," cried Fritz. "Lead the way, Eva; we will follow with your drowsy friends."

"You will have to catch us first," exclaimed Jessie, darting through the door with the speed of a fawn, with Estelle quickly following.

Laughing merrily, the others left the room, and the library, lately occupied by so interested a party, remained deserted.

Their stroll took them through some of the principal streets of the city, it being near supper-time when they returned, with appetites sharpened by the fresh air.

After the evening meal the little party returned to the library, and seated themselves around a table on which Eva had placed a number of curious things brought by her from Egypt; including jewels, ornaments, and objects in gold, silver, and other substances, some of which had been buried for more than forty centuries in the sepulchres along the Nile.

"Here is a pair of ear-rings for which I paid dearly," said Eva. "Just imagine for a moment that they might have been made on an order from Moses to present to a sweetheart at the court of Pharaoh four thousand years ago."

"Or for the Pharaoh who was drowned in the Red Sea, to adorn the ears of his favorite wife!" said Jessie. "Before he was drowned, I mean."

"What is the stone in them?" asked Tom.

"It is carnelian," said Eva. "The designs are unique, and show that the art of the ancient Egyptian jeweller is worthy of recognition, even at this late day. The metals and jewels used by them were gold, silver, bronze, turquoise, lapis lazuli, carnelian, and felspar; they also used ivory and ebony. Recently the mummies of King Amasis and Queen Aah Hotpe were found. With them were discovered gold breast-plates and artificially finished images of animals, flowers, and plants, the work on which is not equalled to-day by that of our best jewellers and lapidaries. The mummies wore name-rings, a fact that leaves no doubt as to who they were. Besides their own names, the engravers show that they belonged to the royal families of Kings Ositarsen II. and III. and Amenemhat III., of the Twelfth Dynasty. That is known as the classical period of Egyptian history, during which art, literature, and industry were in their highest state of development.

"The apartments of the rock tombs in which they were found are sixty feet long and forty feet wide, and contain pillars of the native rock sixteen feet in height and five feet in diameter, while the sides of the rooms and passages are covered with paintings designed with skill and good taste. These tombs are among the most remarkable in Egypt. Some of them are two hundred feet above the level of the river, and are hewed in the solid rock with perfect precision."

"The pyramids were tombs also. I know that much about old Egypt," said Fritz. "They were made big because they were to hold some of the biggest of the emperors. I don't mean the heaviest, but the largest in their doings or their pride."

"Your information about the pyramids is fresh and interesting, Fritz," said Eva, with a smile. "You are surer about their purpose than some of the excavators themselves, who have more than one theory about them."

"Of course I know," declared Fritz. "I know by intuition, which is of more account than all their picks and shovels. Have the pyramids all been opened, Eva?"

"Only a few of them remain to be examined," answered Eva. "Of these few a group of five is located near the village of Dahschur, their construction dating from 3500 B.C. Two of these are built of the sediment of the river Nile baked into tiles, and the other three of huge hewn blocks of limestone.

"But to return to the treasures of the tombs, I may say that the objects found in the death chambers of King Amasis and Queen Aah Hotpe are worth millions of dollars; in fact, it is a question whether money could purchase them at all. The most valuable of Queen Aah Hotpe's personal effects is a massive hand-mirror, the handle and frame of which are of solid gold and the reflector of polished silver. On a beautiful golden diadem, neatly jewelled, the queen's name is engraved in full. In a

gold-covered case, of which the wood was found entirely decayed, was a remarkably pretty bracelet of the queen's. It consisted of rows of beads of gold, lapis lazuli, green felspar (Amazon stone), and red carnelians. Another style of bracelet is composed of a plain gold band surmounted with the figure of the peacock, the feathers being represented by the variegated colors of a large number of precious stones."

Eva was interrupted at this point in her description by Aunt Lida, who entered with a letter from her husband, stating that he, Harry, and Inez would return the following (Sunday) evening. The letter also stated that Stewart Van Dusen, a wealthy placer miner, had invited the boys to Fairplay to see his hydraulic mine in operation, an invitation which they gladly accepted.

After some further examination of Eva's Egyptian treasures the party broke up for the night, Tom and Fritz accompanying the young lady visitors to their home, which seemed to lie far away, to judge from the long time it took them to go and return; though Eva shrewdly decided that all this time was not spent upon the road.

CHAPTER XIV.

SUPERSTITIONS ABOUT PRECIOUS STONES.

AFTER spending Sunday in attending divine service and in other duties suitable to the day, Aunt Lida and the younger members of the family sought the railroad station in the evening to meet the returning travellers. The train rolled in on time, and Uncle Ben, Harry, and Inez received a hearty greeting.

With them came Mr. Van Dusen, a gentleman of middle age, tall and slender in figure, with alert eyes and an intelligent countenance. He was introduced by Mr. White, with the remark that he had consented to be his guest for several days, and then would be glad to take Tom and Fritz back with him to his mine.

The boys warmly thanked Mr. Van Dusen for the invitation, from which they anticipated much pleasure and profit. He replied that he could not answer for the profit, but would do his best to make it pleasant for them, and might be able to show them some things not to be seen in Ohio.

Entering the carriages, the party drove home, the travellers glad of any opportunity to rest after their ride over a mountain railroad track.

On Monday morning, the two gentlemen, with the youthful students, met in the library, their conversation beginning with an account by Fritz of how Eva had entertained them. After a time devoted

to chat on general subjects, Uncle Ben inquired if there was any particular mineral that they wanted to hear about.

"It occurs to me that we have heard nothing about nickel," said Tom; "and though a nickel coin is not quite as alluring as a silver dollar or a gold eagle, nickel as a metal may have something to recommend it."

"That is a fact," said Uncle Ben, "and we will make that our subject. Nickel is very rarely found in its native or metallic state, it being almost always alloyed with some other mineral. Its native state is most nearly approached in its ores by an alloy of nickel and iron discovered in the gold placer mines of Piedmont, Italy, on the river Elvo. The grains resemble platinum, and are strongly magnetic. The ores of nickel are numerous, and most varieties show copper, iron, or cobalt. In fact, it is said to be always associated in nature with cobalt, they seeming to have some close relation. It is stated that jewellers in India use an ore of nickel for giving to gold a rosy hue, but this is doubted. They probably use aluminum, as that metal will produce red gold when alloyed with it. The only condition in which nickel is found in its native state is in meteorites, where it is usually associated with iron. The quantity of iron is much the largest, analyses of these metallic meteorites giving an average of ninety-two per cent. iron, six per cent. nickel, and about one per cent. cobalt."

"How curious that is!" exclaimed Fritz. "Then

we have to trust to the heavens to shoot us down something which is never found on the earth."

"I might almost say the same about iron," said Uncle Ben. "Native iron is found in meteorites, but very rarely on the earth, and the examples there of native iron may all have been shot down from space. Oxygen is too fond of iron to let it remain long except as an oxide."

"Where are the largest deposits of nickel found?" asked Tom.

"The largest and best known mines are those of Sudbury, Canada, where the ore has been followed to a depth of more than six hundred feet, and holds its value and quantity to the deepest workings. But the ores of nickel are much more widely distributed than is generally supposed. There is no doubt that we have plenty of it in Colorado, but it has not been looked for with that perseverance and energy which the prospector applies to his search for gold and silver. Only one mine of any note has been worked for nickel in Colorado. That was the 'Gem' mine in Fremont County, the only producer of nickel in the State. This was originally located as a copper mine, but at a depth of twenty feet copper almost disappeared and nickel became prominent, and also native silver. I have here a specimen from the 'Gem' mine so penetrated with wires of silver that, although broken, it is held together by the pure silver."

"Well, I declare; so it is!" said Tom, looking at it with great interest. "Who would think of silver

acting to hold stones together? What is the origin of the name of nickel, Uncle Ben?"

"It comes from the Swedish, and is a name connected with old Nick, an evil spirit," was the reply. "The name was applied to the metal because its ore, which was copper-colored, deceived the miners, who expected to obtain copper from it. Pure nickel is a bright, silver-white, ductile metal, and almost as infusible as iron. Its uses are for coinage, for electro-plating on iron, and for making metallic alloys. It is also a constituent of German silver, in which it is used as a whitening agent. When added to aluminum in proportion of two per cent. it hardens the aluminum without perceptibly adding to its weight. The kitchen utensils so generally advertised as pure aluminum are composed of the alloy just mentioned. It is sometimes used in medicine as a tonic."

"Are those all the uses?" asked Fritz.

"Not quite all. I have said nothing about its use as a plating material, though the phrase 'nickel-plated' has become quite common. It resists oxidation, and is thus of great utility as a plating for iron and steel implements."

"But I was thinking of what is called 'nickel-steel,'" said Fritz.

"Yes, that is the newest, and likely to become one of the most important uses of nickel. It is remarkable that when steel is alloyed with a small quantity of nickel it becomes much harder and tougher. This has rendered it very useful in hardening iron plating for ships."

"You said that the alloy of nickel and iron was strongly magnetic," said Tom. "Is this all due to the iron?"

"No; nickel is a magnetic metal."

"And are there any others?"

"Yes, cobalt. I have told you that cobalt is always associated with nickel. The fact that they are both magnetic adds to their closeness of relationship. It is true that many substances are magnetic, but only iron, nickel, and cobalt are strongly so."

"That seems very singular," said Tom.

"Mr. Van Dusen and I have an engagement down town," said Uncle Ben, "so I fear we will have to stop to-day with nickel. If you will excuse us, we will attend to our business and return in time for dinner. This afternoon Inez proposes to tell us all something concerning the old superstitions about precious stones. It will be new to Mr. Van Dusen, and he promises to be present."

"Certainly, uncle, we will excuse you," said Tom. "You have given us plenty to think of and to look up. To show you that I have been an attentive listener, I want you to examine my note-books."

"I declare if they are not growing quite bulky," said Uncle Ben. "Well, you will find them useful some day." He left the room as he spoke, while the two boys set themselves to write out more fully their notes on nickel.

In the afternoon, Tom, Fritz, Eva, Aunt Lida, Uncle Ben, and Mr. Van Dusen seated themselves around a table in the library, while Inez covered

one end of it with books of references, which, however, she seldom used. Opening the mineral cabinet, she took out a specimen of lapis lazuli, and said,—

"Perhaps I should have left this mineral for papa to describe, as in this progressive age it hardly deserves a place among precious stones; but as it was used extensively by the Egyptians as an ornament I include it among my specimens. In modern times it has acquired a practical value, since it furnishes us with the valuable paint called ultramarine. It is usually found in Siberia, China, Thibet, Chili, and occurs in some other countries. Lapis lazuli is somewhat high in the scale of hardness, being capable of scratching glass. Before the introduction of precious stones, it held a high place in the estimation of the primitive nations of Asia, while it was the only stone of any intrinsic value known to the Egyptians under the Pharaohs. It is used abundantly in such of their jewelry as has come down to us, being employed in signet-stones, pendants, and charms.

"The statement is made, though I cannot say on what authority, that the Sanctum Sanctorum in King Solomon's temple was built of lapis lazuli, and represented the dark blue of an evening sky made brilliant by stars. As regards the superstitions connected with this mineral, there is one of ancient date to the effect that any one who wore a ring set with lapis lazuli would never be afflicted with rheumatism, while if a piece were pulverized and scattered about the dwelling thieves could not enter."

As Inez laid down the specimen of lapis lazuli which she had been describing, Tom took another stone from the cabinet, saying,—

"I beg pardon for interfering, but what is this stone with its flesh-colored tint?"

"It is that tint to which it is supposed to owe its name of carnelian," said Inez, "which may be derived from 'carneus,' the Latin word for flesh. It is, however, sometimes the color of honey, and is then known as the 'honey carnelian.' In ancient times this stone was esteemed to be of wonderful virtue. It was supposed to cure tumors and all wounds produced by iron, to drive away evil spirits, and to stop bleeding. Other notions concerning it were that it exhilarates the soul, drives away fear, destroys witchcraft, and is an antidote to poison. It was also said to give success in lawsuits and make the wearer rich."

"Here is a pretty piece of green mineral," said Fritz. "If I may follow Tom in propounding questions, I would ask if this is not what is called jasper?"

"Yes," answered Inez. "There is nothing of the precious character about it; in fact, it is a very common mineral, one of the varieties of quartz found in veins. Though this specimen is green, it is found of all colors,—red, brown, green, yellow, etc. It is mostly valued for the use to which it is put for cameos and monumental or mosaic work. But it was highly esteemed of old, and Onomaeritos, who wrote 500 B.C., speaks of the 'grass-green jasper which rejoices the eye of man and is looked on with

pleasure by the immortals.' Pliny describes ten kinds of jasper, and many ancient examples of cut jasper are still to be seen, so wrought as to bring the various colors of the stone into contrast. I may especially name two marvellous vases of this substance in the Vatican,—one of red jasper with white stripes and the other of black jasper with yellow stripes, these varied tints being brought out in the cutting."

"What is this green stone with spots of red lying beside the one you are describing?" asked Fritz. "It looks like jasper, too, only for its color."

"It is a variety of jasper containing blood-red spots, from which it has been named blood-stone. A legend in connection with this stone is, that at the crucifixion the blood which followed the spear-thrust fell upon a green jasper lying at the base of the cross, and that this gave rise to the blood-stone."

"Here is another green stone," said Tom, taking a specimen from the tray. "Is it jasper, also?"

"No; that is what is known as olivine, peridot, or chrysolite, a stone formerly considered of more value than the diamond, and which is still in great demand among the Quakers. A productive field for it is the Navajoe Indian Reservation in Colorado. It is scarcely ever found in a crystalline form, being usually in fragments, but is susceptible of a fine polish, as it has the hardness of quartz. To give it the final lustre, it is, after polishing, immersed for a short time in hot sulphuric acid. It is found of all shades, from the deep green of this specimen to

a light straw-yellow, and when set it is a beautiful gem. What the ancients called topaz was of a green color, and is supposed to have been the same as our chrysolite. It was found in the island of Topazios, in the Red Sea, from which place it derived its name. Diodorus Siculus says," continued Inez, reading from one of her books of reference, "'This place was ten miles long, and was called the island of Serpents from the number of reptiles formerly infesting it. The stone here found was a transparent gem, agreeable in aspect, resembling glass. No one was permitted to land there under pain of death, and no boat was allowed to be kept on the island. Provisions for the few soldiers on guard there was brought at intervals from the continent. The gem was not discernible by day, its lustre being then overpowered by the sun's rays, but at night it was conspicuous by its brightness. The guards who divided the island among their patrols then ran up and covered the luminous spot with a vase. Next day they would go their rounds and cut out the patch of rock thus indicated, and deliver it to the proper person to be polished.' The chrysolite which this is said to represent was considered of great virtue in scaring away evil spirits 'if strung on a hair out of an ape's tail.'"

"How ridiculous!" exclaimed Fritz.

"But it is in keeping with all the ancient superstitions, so far as I have heard of them," said Tom.

"Why, yes; they are not remarkable examples of rare reasonableness and sound common sense,"

said Inez, with a laugh. "But the ancients attributed miraculous powers to almost all precious or semi-precious stones. The agate, of which I believe you have already had a description, was an object of the most fanciful delusions. Orpheus says of it, 'If thou wearest a piece of the tree agate on thy hand, the immortal gods shall be pleased with thee; if the same be tied to the horn of thy oxen when ploughing, or around the ploughman's sturdy arm, wheat-crowned Ceres shall descend from heaven with full lap upon thy furrows.' He adds that every kind of agate is an antidote to the asp's bite if taken in wine; but the more potent brocatello, if merely tied on the wound, cures the scorpion's bite, attracts love, obtains every petition from the powerful, and cures the sick."

"'Brocatello!' That is a new word," broke in Fritz, "and one high-sounding enough to be full of meaning. I beg pardon for interrupting you, Inez."

"That is just what I want you to do, Fritz," she replied, with a kindly smile. "I am here to answer your questions. Brocatello is a porous calcite, usually of a yellow color, but sometimes bluish-red or purple. The ancients believed that when applied to the bite of any reptile it would draw the poison from the wound."

"It is not well to say too much of their superstitions," said Tom, "unless we acknowledge that some of those ancients are living among us to-day. Every little while I read of some one who has in his possession a 'snake-stone' for the cure of snake-bites,

that has been handed down in his family as an heir loom."

"I have frequently read of them," answered Inez; "but I understand that what is called snake-stone is simply a small ammonite, one of the fossil shells of an ancient animal of the same family as the nautilus. But I have not told you all the superstitions relating to agate. It was believed that by burning the agate storms could be averted; the proof of its efficacy in this direction being that if thrown into a caldron of boiling water this was immediately cooled. In order to do good, the agates needed to be strung on a hair from a lion's mane. A variety of agate colored like a hyena was believed to be the cause of domestic quarrels."

During the conversation Jessie had entered, and remained a silent auditor until the present moment. She now took part in the discourse.

"I wonder if any of them ever tried to cool boiling water with an agate?" she remarked. "But I suppose they had then many of the kind of people we have now, who are quite ready to believe without trying. The superstition of those ancient people reminds me of an interview which I once had with our colored servant girl. One day I noticed that she had a rabbit foot dangling on her bosom as a watch-charm, and inquired why she wore it. She looked at me in wonderment, and said, 'Why, de Lor' forgive you, gal; don't you know dat's my lucky charm, and ef I lose dat or give it away I'd never have anudder day's luck as long as I live.' I told her that if

that was the case I would go down to the market and get one. She said, 'Uh, uh, dat won't do you no good; it would be hoo-doo. To git the right kind of a rabbit foot, you got to kill de rabbit in a graveyard, at de dark ob de moon, at twelve o'clock at night, and den take de left hind foot!'"

All laughed heartily at Jessie's story, after which Inez resumed.

"Few gems were invested with more wonderful properties than the turquoise," she said, taking a specimen of this mineral from her cabinet. "Besides strengthening the eyes and cheering the soul of the wearer, it took upon itself the consequences of any fall that might happen to him, since it saved him the fracture of a bone by cracking itself. It was supposed to grow paler as the wearer sickened, and lost its color entirely upon his death; but recovered it when placed on the hand of a new and healthy possessor. If suspended by a string within a glass, and free to swing, it told the hour by the exact number of strokes it gave. The beryl also was a stone notable for its virtues. Early writers tell us that 'It much avails to a good understanding, represseth vain conceits and evil thoughts; it also causeth mirth.' The beryl was a favorite with the ancient necromancers, who, after repeating the necessary adjurations, looked into the stone and pretended to read the answers."

"They are a curious set of old fancies. Don't you think so, Mr. Van Dusen?" said Uncle Ben, now first speaking.

"Very curious, indeed," answered Mr. Van Dusen, who had been listening intently. "I find them highly interesting, as I never heard of these odd notions before."

"What have you to say of the amethyst?" asked Jessie, taking a fine specimen from the tray.

"The amethyst, though now a common stone, was highly esteemed in the eighteenth century," said Inez. "Queen Charlotte was presented with a necklace of amethysts valued at ten thousand dollars, though it would not now sell for five hundred dollars. The amethyst is simply quartz, colored purple by manganese. The deeper the tint the less brilliant the stone; for which reason the ancient engravers preferred the light-colored variety. The pale amethyst was supposed to be the hyacinthus of Pliny, which, according to him, differs from the amethyst: 'Inasmuch as the violet splendor of the amethyst is diluted in this gem, and so far from filling the eye does not even reach it, fading away more speedily than the flower of the same name.'

"The flower referred to by Pliny was not our hyacinth, which is a bulb derived from Persia, but was the blue iris or fleur-de-lis, the blossom of which lasts only one day. The amethyst gets its name from a Greek word signifying intoxicated, from a notion of the ancients that the stone had the virtue of preventing any evil from excess of drinking, and that wine drunk from a cup of amethyst would not produce inebriation. Pliny says, 'If the name of the moon or sun be engraved upon it, and the amethyst

be hung about the neck from the hair of a baboon or the feather of a swallow, it is charm against witchcraft. The jewel keeps off hailstones and flights of locusts, with the assistance of a spell.' In justice to Pliny it is proper to add that, while recapitulating these flights of the imagination, he had quite a laugh at them as the fabrications of lying Greeks; yet he could be credulous enough himself on occasion. Roman Catholic bishops wear a ring of amethyst, and from this it is called the 'Bishop Stone.'"

"Won't you please show us your collection of opals?" asked Jessie.

"With pleasure. This drawer contains nothing but opals," she replied, pulling out a drawer of rich-hued gems.

"How beautiful!" cried Tom.

"And what a variety!" added Fritz. "They show all the colors of the rainbow."

"The opal is a favorite stone with Queen Victoria, who persists in presenting them to friends and relatives," said Inez. "Of course, a gift from royalty must be accepted and consequently worn. Her fondness for the opal has given it the credit in England of being the lucky stone, instead of the unlucky stone as formerly. It is also a favorite with the German royal family."

"Why was it called the unlucky stone?" asked Jessie.

"It gained this reputation from Scott's novel of 'Anne of Geierstein.' In this the opal is stated to bring ill fortune to the possessor. No such notion

was attached to it in former times. Here is what Nicols wrote two hundred years ago: 'The opal is a precious stone which hath in it the bright fiery flame of the carbuncle, the fine refulgent purple of the amethyst, and a whole sea of the emerald's green glory, and every one of them shining with an incredible mixture, and very much pleasure.' Cardanus says, 'I bought one for fifteen crowns, which gave me as much pleasure as a diamond of five hundred aureos.' Onomacritus, 500 B.C., says, 'The delicate color and tenderness of the opal remind me of a loving and beautiful child.' Pliny says, 'It is made up of the glories of the most precious gems, and to describe it is a matter of inexpressible difficulty.' Petrus Arlensis, who wrote in the time of Henry IV., says, 'The various colors in the opal tend greatly to the delectation of the sight; nay more, they have the very greatest efficacy in cheering the heart and inward parts, and especially delight the beholder's eyes. One in particular came into my hands in which such beauty, loveliness, and grace shone forth that it could truly boast that it drew all gems to itself, whilst it surprised, astonished, and held captive, without escape or intermission, the hearts of all that beheld it. It was the size of a hazel-nut, and was grasped in the claws of a golden eagle wrought with wonderful skill. It had such vivid and various colors that all the beauty of the heavens might be viewed in it. It sent out such bright and piercing beams that it struck terror into all beholders.' "

"That last gentleman certainly was not wanting

in imagination," said Uncle Ben. "The bright and piercing beams from your opals do not strike terror into me, for one."

"Why, no," said Mr. Van Dusen; "they are certainly not piercing, though very beautiful."

"The opal was a favorite gem in Venice at the time of the great plague," continued Inez; "and it was noticed then in the hospitals that before the death of those who wore those jewels the stone sometimes brightened on the victims' fingers. Not knowing that opals are affected by the heat of the hand, and noting that the colors shone with unwonted brilliancy only in cases of people afflicted with the plague, who were consumed by fever, which was at its height just before death, the people attributed the patient's death to the influence of the stone."

"That is one of the ways in which superstitions are born, no doubt," said Jessie. "Where are opals found, Inez?"

"Until within a few years the finest opals came from Hungary," she replied. "At present the opals producing the greatest play of colors are found in Queensland, but a recent find of opals at Moscow, Idaho, bids fair to rival stones from any other locality. There is an old mine a few miles north of Pachuca, Mexico, near the little village of Regla, which furnishes some beautiful opals, much resembling those found in Queensland. For some reason this mine is not being worked. The mines of the State of Queretaro, Mexico, produce a large quantity of inferior opals, with an occasional gem."

"And where are the finest examples to be found?" asked Fritz.

"The finest opal of modern times was one worn by the Empress Josephine, which was called the 'Burning of Troy' on account of its appearance, which had the effect of flames of fire.

"The Imperial Cabinet of Vienna has a magnificent opal on exhibition. It is five inches long and two and one-half inches wide, and weighs seventeen ounces. The origin of this opal is unknown, but it has been at Vienna for two centuries. Black opals are said to be the most valuable at the present time. One was sold in Paris a short time since for five thousand dollars. Queen Victoria owns a magnificent coronet of opals, the fitful gleams of which suggest the cool rays of moonlight, and again the warm glow of a tropical sun.

"The Countess of Dudley has a necklace of opals valued at three hundred thousand dollars. Christine Nilsson possessed a wonderful Hungarian opal which was given her by the Emperor of Austria, and there is a beautiful opal in Vienna which weighs seventeen ounces."

"Isn't the cat's-eye something like the opal in its change of lustre?" asked Jessie.

"Not much. It does not possess the opal's play of colors, but derives its name from its changing, pearly light. I have an example here, from which you can see its character. The cat's-eye is a chrysoberyl, and ranges in hardness between topaz and sapphire. The finest specimens come from Ceylon,

and a perfect gem is still of considerable value. The Hindoos esteem it next to the diamond. The largest cat's-eye known is one inch and a half in diameter, and formerly belonged to the king of Kandy."

"His royal sweetness, I suppose, from his name," said Jessie.

"But this Kandy is spelled with a K, not with a C."

"I see. And where is the charming kingdom of Kandy?"

"It was an inland kingdom on the island of Ceylon, but it has been suppressed, except the town, still called Kandy. Brazil also produces the cat's-eye, which is found there in the river washings. But most of the cat's-eyes that are now worn in jewelry are a species of shell so ground as to produce the effect of an oriental stone. They are very soft, and can be scratched with a knife-blade."

"You told me once," said Jessie, "that the ruby was thickly overlaid with old and odd notions,—superstitions, I suppose you call them."

"So it was," answered Inez. "Among these ancient fancies it was supposed to tell the wearer, by the frequent change and darkening of its color, that some inevitable misfortune was impending, and, in proportion to the greatness of the evil, it was believed to assume a greater or less degree of darkness or opacity. Another superstition was that it gave one the power of seeing in the dark if hung around the neck. It was also said to cure diseases of the eyes if tied in a linen cloth over the forehead. Plutarch says, 'It is discovered when the moon is waning, to the

sound of fifes, and is worn by people of exalted rank.'

"The brilliancy of the ruby is well illustrated by the stories of some of the early Chinese travellers. One of them, in his description of the island of Ceylon, says that 'In the seventh century a ruby was elevated on a spire, the light of which illuminated the skies.' Another Chinese traveller mentions that early in the fourteenth century an officer was commissioned by the Emperor of China to purchase a carbuncle of great lustre, which was used as a ball on the emperor's cap. It was of such unusual brilliancy that at the grand *fêtes* held at night its lustre filled the palace. For that reason it was called the 'Red Palace Illuminator.'

"Another Chinese statement concerning the origin of the rubies of Ceylon was that Buddha, the divine teacher, sprinkled the land with sweet dew, whose drops were converted into the gems. The largest oriental ruby known at present was brought from China by Prince Gargarin, governor of Siberia, and is now in possession of the Czar of Russia. Peter the Great of Russia, when he left England, presented King William with a ruby valued at fifty thousand dollars, which he produced from his vest-pocket and placed in William's hand, wrapped up in a piece of brown paper."

"That looked as if he wanted to make a sensation," said Tom.

"Yes. But had we not better close with the rubies? I fear I am tiring you."

"I don't know when I have spent so pleasant an hour," said Mr. Van Dusen. "Speaking for myself, I would prefer that you continue."

"And I also," said Tom. "I should not have supposed that so many queer ideas could grow up in people's minds."

"Perhaps Inez is tired," said Fritz, "and we should excuse her. At the same time, I could listen longer with pleasure."

"I thank you all for your compliments," said Inez. "But too much at once is not a good rule. I think we had better adjourn our session till a later date."

"That is an excellent decision," said Aunt Lida, "for supper is on the table, waiting, and the dining-room invites us."

"Mrs. White, may I ask where your daughter obtained so thorough a knowledge of precious stones?" asked Mr. Van Dusen. "I never met any one quite so well up in this subject."

"She began when she was a little girl," said Aunt Lida, "and would spend hours along the banks of Cherry Creek and Platte River, gathering agates, jasper, petrified wood, and quartz. As soon as we were able, we bought books on the subject for her to study. She is now said to be a better judge of precious stones than most of the jewellers."

"She has certainly got together a magnificent collection," replied Mr. Van Dusen.

CHAPTER XV.

A VISIT TO THE FAIRPLAY MINE.

TUESDAY morning found Tom and Fritz standing before their uncle's cabinet of minerals examining the specimens, and occasionally referring to a copy of a work on mineralogy which lay open on the table before them. They were soon joined by Mr. Van Dusen and their uncle Ben.

"I'm glad you came, uncle," said Fritz. "Tom and I have been puzzling our brains over one of the most beautiful specimens in the case, and have not been able to get to the true inwardness of it. I mean the one which has branches like a tree, and yet seems to be composed of crystals."

"Not exactly composed of crystals, but covered with them," said Uncle Ben, lifting the specimen carefully from the case. "It is a twig of sage-brush which Harry repeatedly dipped into the waters of the Great Salt Lake. This, you know, is in Utah, and is salter than the ocean itself. The branch was alternately dipped and dried until it became covered with the crystals of salt which you see upon it. While we are upon this subject, I may as well tell you something about salt, or 'halite,' as it is called when considered as a mineral. As occurring in the solid state in mines it is known by the name of rock

salt, while in chemistry it is called chloride of sodium. That is to say, it is a compound of the gas chlorine and the metal sodium. Salt is pretty generally distributed all over the world, having been deposited, it is supposed, from old lakes or seas of salt water which long ago evaporated, leaving only the salt. It is now found in two forms,—that of rock-salt and that of brine, or water very rich in salt."

"Where is rock-salt principally found?" asked Tom.

"The most extensive mine in the United States," said Uncle Ben, "is near New Iberia, in the State of Louisiana, where the salt is found in great masses beneath the solid rocks. Near Monserrat, Spain, there is a hill of rock-salt more than five hundred feet high. The island of Ormus, in the Gulf of Persia, is entirely formed of rock-salt. The Indus, one of the greatest rivers in Asia, in the upper part of its course cuts through many hills of rock-salt. I might name dozens of other important localities, but will speak only of the salt mines at Wieliczka, in Galicia, the most famous in the world. These have been worked for more than six hundred years, and the workings form an underground city, with its streets, squares, etc., and with over thirty miles of railway. The depth reached is about twelve thousand feet."

"It is found also as brine, you say," remarked Fritz.

"Yes. These brine deposits occur far underground, perhaps as remains of old lakes or pools

whose water has not quite evaporated. The brine is raised by pumps and the water driven off by heat."

"Are there any such deposits in the United States?"

"Several very rich ones. For years past the salt wells of New York have supplied much of our table salt; but our supply comes largely from Michigan, whose wells are now extensively worked."

"What is salt-cake?" asked Tom. "I notice that it is frequently quoted in market reports."

"That is quite another substance, it being sulphate of soda, or a compound of soda and sulphuric acid. It is used extensively by glass-blowers, and is sometimes employed in medicine. But to come back to our subject, one mathematician has calculated that the ocean contains four hundred thousand billions of cubic feet of salt, which, if piled up, would form a mountain mass one hundred and forty miles high and one hundred and forty miles in length and width. It would cover all Europe to the height of the summit of Mont Blanc, which is about sixteen thousand feet above sea-level."

"Has salt been very long in use?" asked Tom.

"Probably from the earliest days of human history. It was then obtained by evaporating the waters of the ocean, and that is still done in some parts of the earth."

"Are there historical accounts of its use?" asked Mr. Van Dusen.

"Oh, yes; many of them. The art of making salt was known in early times to the Gauls, the an-

cient inhabitants of France, and to the Germans. The process was a very simple one, for Pliny informs us they did nothing more than throw salt water on burning wood, when the water was evaporated by the heat and the salt left adhering to the ashes or charcoal. The Romans made salt a source of revenue six hundred and forty years before the birth of Christ, and part of the pay of the Roman soldiers was made in salt, which was thus called salarium. From this we derive our word 'salary.' Venice owed the commencement of her prosperity to the preparation of salt, which enabled her to supply all Italy. In this city of the sea it was easy to obtain it in abundance. In process of time the Venetians, not satisfied with their practical monopoly of the trade, seized the salt works of their neighbors, and once forced the king of Hungary to shut up his salt mines. The sale of foreign salt by any subject of the Venetian Republic was punished as a crime against the state, his house was razed, and he himself was condemned to perpetual banishment."

"You spoke of the Great Salt Lake of Utah," said Fritz, "where Harry covered a sage-bush twig with salt crystals. I should really like to know more about it."

"It is a remarkable body of water," said Uncle Ben, "only equalled in its richness in salt by the Dead Sea of Palestine. It is about seventy miles long and thirty-five miles wide, and is so salty that scarcely any living thing is found in it. When the water recedes from the beach in the dry season the

shores are left covered with thick masses of salt. The water is so buoyant that a man may float stretched at full length on his back, having his head and neck, both legs to the knees, and both arms to the elbow entirely out of the water. If the bather assumes a sitting position with the arms extended, the shoulders will remain above the surface. The first mention of the Great Salt Lake was by Baron La Hontan in 1769, he having been told of it from the Indians west of the Mississippi. General John C. Fremont was the first to explore and describe it. His visit was in 1843, and in 1850 it was surveyed by army officers."

"Great Salt Lake isn't much of a name," said Fritz. "Did not the Indians have some other name for it?"

"Yes. It was called by the Indians 'Timpanogos.' Just what that means is more than I can tell you. Perhaps it has some reference to salt."

"Is rock-salt very heavy?" asked Mr. Van Dusen.

"It is about equal to ordinary rock, its specific gravity ranging from 2 to 2.5."

"Uncle Ben, what is meant by specific gravity?" asked Tom.

"That is the scientific term for the comparative weight of bodies. Water is employed as the standard, its specific gravity being taken as 1."

"And if you wished to find the specific gravity of any substance, how would you proceed to obtain it?" asked Tom.

"The method is to weigh the substance at first in

a fine balance; then suspend it in water and weigh it again. It will now appear to have lost weight, it being buoyed up by the water. The weight of the substance in water is then subtracted from its weight in air, the latter is divided by the difference, and the quotient is the specific gravity of the substance. For example, if a fragment of some mineral should weigh in the air 100 grains and in water 80 grains, then 100 divided by 20, the difference between the two weights, equals 5, so that the specific gravity of the substance is 5. In other words, the twenty grains lost in the water represent the weight of a body of water equal to that of the mineral, so that this substance, weighing one hundred grains, is five times as heavy as water. Quartz has a specific gravity of about 2.5. A cubic foot of this substance will almost invariably weigh one hundred pounds, or twenty cubic feet of it weighs a ton if it is mined and broken up. When measuring quartz in place in a mine engineers allow thirteen feet for a ton."

"Are the metals much heavier than rock?" asked Fritz.

"Some of them. The specific gravity of gold is 19; that of platinum is 21; gravel and rock generally weigh about 2.5; diamonds about 3.5. That is why those substances which weigh more than 2.5 sink to the bottom in washing for them, while the lighter materials float near the top and are washed away."

"I hope to let our young friends into some of the secrets of washing," said Mr. Van Dusen. "Of

course, a practical demonstration goes farther than a description. I shall leave to-morrow morning for my placer mine at Fairplay, and should be glad to have them go with me. Perhaps, though, they will prefer to follow in a few days."

"I should much rather go with you, Mr. Van Dusen," said Tom, eagerly.

"And so would I," said Fritz. "And I hope you will be kind enough to point out to us the objects of interest on the way. We would miss all these if we went alone."

"Not all, I fancy. Some of them you couldn't help seeing; but I may be able to help you in your sight-seeing. We shall have to leave here at eight o'clock, as the train starts at eight-thirty. And don't forget your overcoats, for it gets cold at the mine after the sun hides himself behind the western mountains."

The two gentlemen now went into the city to complete some business to which Mr. Van Dusen had to attend. As the day was a fine one, Tom and Fritz proposed to Harry another ride to Cherry Creek. He agreed, and his two sisters were quite ready to accompany them, so it was a large and lively party that drove to the scene of the gold-panning experiment. Tom and Fritz tried their luck again at gold getting, though with very poor results. They soon gave it up to join Inez in her search for minerals along the creek, while Eva amused herself in sketching a spot of special beauty. They returned in the evening without much in the way of spoils,

but fresh and joyous from their day's outing in the mountain air.

The two boys were up betimes the next morning, and were all ready for the proposed trip an hour before Mr. Van Dusen thought it necessary to begin. Reaching the station in good time, they bade a hearty good-by to Uncle Ben, who had come to see his friend off, and were soon rolling swiftly along the mountain railway.

The young travellers found immense enjoyment in the wild scenery of the Upper Platte Cañon, through which the railway twisted in sharp and sudden curves, the sides of the cars at times almost brushing the precipitous walls of the cañon. Here and there short bridges were flung over cataracts of the pure mountain stream, along whose banks fishing parties appeared at intervals. At one spot, where the cañon widened, a party of Sunday-school children were having a merry, romping time at their annual picnic, and in high glee shook their handkerchiefs and sun-bonnets at the swiftly passing train. Fritz, Tom, and Mr. Van Dusen, who were standing on the rear platform the better to observe the grand scenery, waved their handkerchiefs back at the happy little children.

Farther on the cañon again narrowed and widened in quick succession, and the train passed immense granite quarries, where large blocks were being prepared for the new capitol building. At another point the road seemed to be hemmed in with blocks of a white variety of wood, each about two feet in

length, and entirely stripped of bark. Mr. Van Dusen explained that the blocks were of white fir and were intended for the Denver paper-mills, where they would be ground into pulp and made into all kinds of paper.

Many other features of interest quite new to the boys were observed as the train pursued its course along the mountain road. At one o'clock they arrived at Como, and were met at the station by Mrs. Van Dusen, who had driven over to meet them. In a few minutes the party were seated in a surrey, drawn by two snappy little mustangs, which whirled the party over the hills to Fairplay, a distance of twelve miles, in a little over an hour. The boys, who found Mrs. Van Dusen very chatty and agreeable, enjoyed every moment of the ride. After resting during the remainder of the day, observing with pleasure the grand surrounding scenery, they started the next morning with their host for the mine, which was reached after a brisk walk of twenty minutes.

After reaching an elevated spot which gave an excellent view of the situation, Mr. Van Dusen stopped and pointed out the deep excavation before them.

"Standing at this point you can see all the workings in the mine," he said. "It is ninety feet from the bottom of the pit to where we stand, and the cutting is fully two hundred feet wide, and yet all that vast amount of material has been washed away in the last three years."

"I should call that moving dirt pretty rapidly," said Tom.

"It is a long way removed from the old style of panning out gold which you tell me you tried yesterday on Cherry Creek," said Mr. Van Dusen. "And this method of working a placer, compared to the old method of sluicing, is like the speed of a modern express train to that of an ox team. The streams of water that you see playing against the gravel bank yonder come with immense force, as the water descends one hundred and eighty feet before it escapes from the nozzle of the Little Giant."

"Little Giant?" queried Fritz.

"That is our home name for the machine which you see tearing away the gravel from the filled-up river-bed, which geologists tell us these deep deposits of earth and gravel are. The Little Giant has a deflecting nozzle, and is balanced by a counterweight so correctly that a child can move it. The gold-bearing gravel on the bed-rock is very compact, but the water, coming from its great elevation, strikes it with such terrific force that the stream of water is like a solid bar. It easily tears it away,—the gravel, —and soon undermines the great bank of dirt, dropping it into the pit below. There the lumps of earth and stone are still further broken up by the force of the water and prepared to go into the flume. In passing through this, the gold, being so much heavier than the gravel, will hug the bottom, and finally stop in some of the many riffles. The gravel, now freed

of its gold, passes onward and out of the flume to the great dump below."

"What is a riffle, if I may venture to ask?" said Tom.

"It is a depression in the bottom of the flume. We set up cross pieces of wood, or in other ways make catch-basins for the gold."

"You spoke of the bed-rock," said Fritz. "What do you mean by that?"

"You may see it over most of the bottom of the working," said Mr. Van Dusen. "You can see from here that all the space from which the gravel has been removed is a brown rock, above which the gravel lies. It was formerly all covered deep with gravel. It is a brown sandstone which may have formed the bottom of the old river. As the gravel rests upon it, it is called by miners the bed-rock. The gold is always in the gravel; we never think of looking for it in the rock beneath."

"I know," said Tom. "Uncle Ben explained how the gold was washed from quartz veins far up the stream and dropped down in its gravel and sand. Oh! Look quick, Fritz! the bank is falling in."

"What a thrilling sight!" cried Fritz, as a great mass of earth and gravel, undermined by the water, came down with a crash. "Mercy on us! Isn't there danger of the miners being buried under it?"

"None at all," said their host, smiling at their excitement. "There is no danger of their being caught. The bank always gives warning before it breaks."

"Gives warning! Well, that is certainly very kind of it," said Fritz. "At any rate, I'd think so if I was working there. But I did not hear any warning."

"You would have seen one if you had been closer," said Mr. Van Dusen. "About fifteen or twenty minutes before it finally tumbles fragments begin to fall from about half-way up the bank. These fragments increase in size until a chunk perhaps as large as a wheelbarrow drops. Then look out! it is time for the men to move back, for the whole bank of earth and gravel will soon cave in as far back as undermined."

"Have any of your miners ever been caught by the falling earth?" asked Tom.

"Only once, and that was so funny an affair that I feel like laughing every time I think of it. One day, about a year ago, I was holding the pipe and directing the stream of water from the Little Giant against the bank, when my wife came up with several lady friends from Denver who wanted to see the operation of the mines. One of the ladies remarked that I had an easy job, and said she believed she could do that. I told her to come and try it, at the same time putting my rubber coat over her, and then my rubber cap and cape. After showing her how to handle the nozzle, I started to go up the hill and turn on more water.

"At that time there was a miner working for me that the boys called Monsieur De Trop, a very airy little French dude. As soon as I was out of sight he got right under the bank, and swung his pick

right and left as gracefully as a dancing-master, showing off before the ladies. Well, the bank fell and covered poor Monsieur De Trop with nine feet of top dirt. I heard a chorus of female yells, and jumped to the pit, grasped the nozzle, and in less than a minute the little Frenchman was pulled out more dead than alive. In a few minutes he had recovered sufficiently to let out a string of French 'sacres' which sounded very much like swearing. But, as neither of the ladies understood French, I didn't object, and let him 'sacre' to his heart's content. That evening he called for his pay, and I have never seen him since.

"If you would like, we will now go down into the pit, where you can each try to handle the water in the Giant. But I must warn you to keep away from the front of it, for the water comes with force enough to kill a man if it should strike him fairly in the middle. You can also try your hand at panning for gold, and may keep all you can get as a souvenir of your visit."

"If we get no more than we got on Cherry Creek, it won't make us hump-backed to carry it," said Tom.

"The whole bank from top to bed-rock in this mine will average thirty cents in gold to the yard," replied their host; "and I have got as high as thirty-two dollars to a pan on the bed-rock."

"That will beat Cherry Creek all hollow," cried Fritz. "The gold must lie low in this mine. Can you show me such a spot now? That is where I want to do my panning."

"No," said their host. "Dirt as rich as that isn't plentiful. You are at liberty to take a panful anywhere in the pit, but I would advise you to get it as near bed-rock as possible."

Fritz and Tom each tried holding the nozzle, and found it no difficult task under their host's direction. After this experience, each of them washed out a panful of gravel dug as near bed-rock as they could go. They were much astonished at the large amount of gold obtained. When weighed by Mr. Van Dusen in the evening, Fritz had about nine pennyweights, and Tom's portion was seven and a half pennyweights. As the gold from that mine was worth eighteen dollars per ounce or ninety cents per pennyweight, Fritz's gold was worth eight dollars and ten cents, while Tom's was worth only six dollars and seventy-five cents. Both of them, however, were well pleased, and they thanked Mr. Van Dusen warmly for his generosity.

The following day was spent by them in visiting Mount Lincoln, Mount Bross, and other points in the vicinity, their host and his amiable wife accompanying them. On the succeeding day they returned to Denver, highly pleased with their trip and with the knowledge gained.

At the breakfast-table next morning they showed with much pride and satisfaction the results of their panning. Uncle Ben now informed them that Harry had just returned from a new mining camp in the mountains, and while there had located three gold claims, one for each of them and one for himself.

"You don't say so!" cried Fritz, in high excitement. "Do you hear that, Tom? You and I each own a gold mine! I hope it turns out as rich as our last panning, nine pennyweights to the pan. Uncle, where is Harry, that I may thank him for his kindness?"

"He had an early breakfast, and is off on business. But I don't think he will expect thanks."

"He shall have them, then," exclaimed Tom. "And you, too, uncle; for I am sure you had some part in it. What shall we do, Fritz, with our mines?"

"Wait till Harry develops his. If he strikes it rich, it will pay us to come back from Ohio to Colorado."

"That's a wise decision, Fritz," said their uncle, laughing. "Let Harry pull your chestnuts out of the fire. I hope, for your sakes, that it may pan out well."

"Many thanks, Uncle Ben," said Fritz. "As for Harry, he can try for his own chestnuts. If he finds any, then we will go for ours. But how do you get an original title to a mine? I meant to have asked that question before, but it was driven from my mind by my throng of new ideas."

"The first thing to do is to find your vein," said Uncle Ben.

"First catch your hare before you roast it," broke in Fritz. "Excuse me, uncle, but that fit in so neatly."

"Laughing at your old uncle, are you, you rogue?

Well, the vein found, have some assays made of the stuff that comes out. If these are satisfactory make a hole ten feet deep, which is called the discovery shaft. The United States mining law allows you to locate a piece of ground fifteen hundred feet long by six hundred feet wide. First get the width by stepping off from each side of the discovery shaft one hundred paces, which will be about three hundred feet, and mark the end of your line in each direction by a small mound of rocks or a stake. From each of these markings, step off seven hundred and fifty feet each way, marking each corner. But you must be careful to make the length of the claim conform to the trend of the vein, so as to hold all of it you can. You will then have six stakes or monuments, two at each end and two on the sides.

"This completed, you must write out a notice of your claim and post it at the discovery shaft. A copy of the notice needs to be sent to the County Recorder, and you then have a title which is good against the world so long as you comply with the United States mining law, which is, that you must do at least one hundred dollars' worth of work on the mine each year."

"Is there any particular form in which the notice must be written?" asked Tom.

"No, there is no regular form. Every locator uses his own words. I have found it best to write my notices with a lead-pencil, as the writing will last as long as the paper on which it is written. If you

will excuse my absence for a moment, I will get you the original notice from my mine, written in 1879."

Uncle Ben left the room, from which he was absent about five minutes. He returned with a yellow and weather-stained square of paper in his hand.

"I thought I could lay my hand on it at once," he said, "but it took me a few minutes to find it. Shall I read it to you?"

"Certainly. We shall be glad to hear it."

Uncle Ben read as follows:

"NIBELUNGEN LODE.

"Notice is hereby given that I, the undersigned, claim fifteen hundred feet on this lode in accordance with the United States mining law approved May 10, 1872. This notice is placed in the northeast corner of the claim, at stake marked No. 1; whence the claim runs in a southeasterly direction fifteen hundred feet to a monument of stones marked No. 2; thence in a westerly direction six hundred feet to a monument marked No. 3; thence in a northerly direction to a stake marked No. 4; thence in an easterly direction six hundred feet to the place of beginning. A copy of this notice is placed on a stake at the discovery shaft, about the centre of the claim.

"Located this 18th day of June, 1879.

"Recorded July 10, 1879.

"BENJAMIN WHITE.

"Witness, CECIL C. MORGAN."

"That notice seems to have weathered the storms of twenty winters, and is yet in good order," said Tom. "That looks well for pencil writing, I must admit."

"The reason it has not been destroyed is that I placed it in an old yeast-powder can, where it lay undisturbed for nearly three years, or up to the time I received a patent for the mine," replied Uncle Ben.

"But if you had a perfect title before, why did you get a patent?" asked Fritz.

"To save both my money and my mine," said Uncle Ben. "When a mining claim is patented, it is not necessary thereafter to do the one hundred dollars' worth of work each year. Before obtaining the United States patent, I could only give a quit-claim deed in case I sold to others; whereas now I can give a warranty deed, and the title is absolutely perfect. But to obtain a United States patent to a mining claim, five hundred dollars' worth of work must have previously been done and the application for a patent published for sixty days. If, after the lapse of that time, there are no adverse claims to the property, the patent will issue in its regular turn from the Land Office. The government receives five dollars per acre for the land."

"Thanks; I now understand it," said Tom.

CHAPTER XVI.

THE SEMI-PRECIOUS STONES.

WHILE Uncle Ben and his nephews sat chatting at the breakfast-table, Inez proceeded to the library, where was arranged a lot of precious and semi-precious stones on the table. She had promised to continue her discourse on this subject, and the boys soon joined her. After some minutes spent in examining the specimens, she took up a pretty green stone and said,—

"In my last talk to you, I mentioned the chrysoberyl and cat's-eye. Here is a remarkable stone, belonging to that family, called the Alexandrite."

"I wonder if Alexander the Great stood godfather to it," said Fritz; "or was it some Alexander the Small?"

"It was named in honor of Alexander I. of Russia, as the stone was discovered on his birthday, November 6, 1777."

"You speak of it as being remarkable," said Tom. "On what grounds? I see nothing remarkable in its personal appearance."

"That is because you have not fully made its acquaintance," said Inez. "It is just in its personal appearance that its peculiarity lies, since it has the distinction of possessing two distinct colors. By

daylight it is a bright olive-green, as you see it now, while when viewed by artificial light it is of a dull rose-red. Under the electric light, however, it becomes green again. It is a very rare stone, and thus far has been found only in Russia and in Ceylon. Specimens are sometimes found which have the peculiar characteristics of the cat's-eye, and which are therefore called Alexandrite cat's-eyes. If I may now return to the subject of agates, which have been previously described to you, I might call your attention to the examples I have laid out here."

"They seem to me to be of a better color than those we have seen before," said Tom.

"Yes; but unfortunately this color does not properly belong to them. These agates are from Bohemia, where they are cut and colored or dyed. This process of coloring agates goes back to ancient times. Even in the days of Pliny more stones were colored artificially than naturally; and he further says that in Arabia the agates were cooked seven days and seven nights in honey, which increased their effectiveness as ornaments. In 'The Devout Life,' by St. Francis de Sales, published in 1708, this sentence occurs, 'All kinds of precious stones, cast into honey, become more brilliant thereby, each one according to its color; and all persons become more acceptable in their vocation when they join devotion with it; household cares are thereby rendered tranquil, the love of husband and wife more sincere, the service of the prince more faithful, and all kinds of business more easy and pleasant.'"

"Isn't that comparison a little far-fetched?" queried Fritz. "I suppose the idea is of adding sweetness to hardness, like boiling agates in honey. I see that these stones present layers of different shades of color. Can you explain that?"

"It is simply due to the fact that some of the layers are more porous than others, and more readily absorb the honey."

"And does honey alone make these beautiful colors?" asked Tom. "Is the boiling the whole process?"

"No; after the agate has lain in hot honey for ten or twelve days it is taken out, washed in water, and then placed in a dish containing hot sulphuric acid. The acid penetrates the stone and acts upon the honey, changing it to a carbon, which in a short time becomes either red-brown or black in color. If I had some sulphuric acid and honey here, I could show you a very curious experiment in chemistry to illustrate what I have said, but you can readily try it yourselves. Fill a tumbler about one-third full of sugar syrup, made thick. Put the same amount of sulphuric acid in another tumbler. You will have two colorless liquids. Now pour the contents of one into the other and in a few seconds you will have a black solid,—a chunk of charcoal, due to the action of the acid on the honey."

"How strange!" exclaimed Tom. "I shall certainly try that the first chance I have. Two colorless liquids make a black solid! That sounds like magic."

"It is one example of the magic of chemistry.

There are many others equally magical in appearance."

"Here is a green agate. Is this natural?" asked Fritz.

"No," said Inez. "That agate has been colored green by steeping it in a boiling solution of iron sulphate, commonly known as green copperas, and subsequently placing it for a short time in a hot oven. Here is a stone of a lighter green, but equally artificial. It is made to take on that beautiful green tint by placing it in a hot solution of sulphate of nickel. Blue agates may be made by placing the stones in a hot solution of the yellow prussiate of potash, and then dipping them into muriatic acid in which some iron wire has been dissolved. They are also sometimes produced by placing the stones in a solution of blue copperas, or sulphate of copper, and afterwards in ammonia. The first method, however, yields the most permanent dye.

"Other tints are given agates by immersing them in a boiling solution of aniline for one hour, then plunging them into cold water. As regards natural agates, the largest and finest stones are now brought from Uruguay, and are known in the market as 'Brazilian agate.' The stone known as 'Scotch pebble' is an agate containing fine hair-lines, as layers and concentric markings. It was formerly extensively used in jewelry."

"What is this curious specimen?" asked Fritz. "It seems to have a Maltese cross running through it lengthwise."

"That is Andalusite," said Inez. "It is so named from Andalusia, Spain, where it was first discovered. The cross does run through it from end to end. I saw something like it a few days since in a confectionary store, in some candy in which the words 'I love you' penetrated lengthwise through the stick, and appeared no matter where it was broken. When of good color the Andalusite makes a rich pellucid green or red gem. It was formerly known as Micaphyllite, or adamantine spar."

"Of what is it composed?" asked Tom.

"Of silica and alumina. Chemically stated, it is a silicate of alumina. The stone is a hard one, and will easily scratch glass, its number on the scale being 7½, the same as garnet."

"Here is a bluish-green stone, which must belong, I should say, to the Andalusite family," said Fritz. "But instead of a cross it seems to have a star passing through it."

"That is called the Chlorastrolite, or green-star stone," said Inez. "It is rare, and is only found in Isle Royale, Lake Superior, where it occurs as pebbles on the shores of the island. It is finely radiated or stellate in structure, and when polished is highly chatoyant on the rounded sides."

"What do you mean by chatoyant?" asked Tom.

"That is one of the technical words which we fall into the way of using," said Inez. "It means the property of changing, like the prism in a cat's-eye. When moved, the starry prism in a Chlorastrolite seems to change from place to place."

"That is certainly curious. But what is this very pretty stone?" asked Tom, taking up the specimen to which he referred.

"It is not only pretty, but rare," said Inez. "That is, it is rare to find one like this. It is called Aventurine, or gold stone. The specks which sparkle like gold are really tiny atoms of mica which permeate the stone. But nearly all the Aventurine of commerce is artificial, being made of glass into which brass filings have been dropped when the glass was in the melted state. The discovery is said to have been accidental, and the stone is therefore named Aventurine, from the French, *par aventure*. Beautiful specimens can be obtained by fusing together sand, carbonate of soda, carbonate of lime, and bichromate of potash."

"I beg pardon for reminding you that you have passed by this very beautiful yellow crystal," said Fritz, pointing to the specimen he meant.

"Why, I was leaving that to speak of at some future time, but will take it up now, since it has attracted your attention. It is a beautiful stone, as you say; and I am certain that after I have had it cut it will present almost the brilliancy of a diamond. It is an oriental topaz, and was found in Montana."

"That makes it an occidental one, I should say," remarked Fritz. "It becomes awkward for the name when an oriental stone gets so far west. What does this specimen weigh?"

"In the rough, as at present, it weighs thirty-four and a quarter carats. When cut, it ought to make a

gem weighing about thirteen or fourteen carats; perhaps more. I have tested it, and can see no flaw or feather in it."

"How did you test it?" asked Tom. "I want to know how to do the same thing when I pick up a pocketful of stones like this."

"Plums of that sort don't grow by the pocketful," said Fritz.

"The method I took was," said Inez, "to place the crystal in a glass tube, which I filled with kerosene. Then holding it towards the sunlight I looked carefully at the stone. If there had been a speck or flaw in it, the kerosene would have made it plainly visible. This topaz is really a yellow sapphire, and is next to the diamond in hardness. The true topaz is only eight in hardness."

"If it is a sapphire, why do you call it topaz?" asked Tom.

"Out of compliment to its color," answered Inez. "It is true, however, that, though the normal color of topaz is yellow, it appears in many other colors, such as pink, wine-color, light-green, light-blue, orange, and white. There is on exhibition at the British Museum a large collection of topazes from Siberia, among which are many of a light-blue color. The topazes of Brazil are mostly of a rich yellow color, but recently specimens of a deep carmine to light pink have been discovered. Brazil also furnishes a blue-green topaz much resembling the aquamarine. The finest white topaz comes from New South Wales, where it occurs in the form of washed

pebbles in the gravel of the rivers. In the United States, topaz is most abundant around the base of Pike's Peak, notably in Cheyenne Cañon, and is also found on Mount Antero, Colorado. In the Bibliothèque Royale, Paris, there is a topaz set in a ring having the portraits of Philip II. and Don Carlos deeply cut in it. There is also a topaz of a citron-yellow color on which an image of Bacchus is cut. In chemical composition, the topaz is a silicate of alumina containing fluorine. I may further say that it becomes electric when rubbed or exposed to heat."

"Here is a very pretty dark-yellow stone, 'topazolite,'" said Tom. "No doubt that belongs to the same family."

"The resemblance is only in its color," said Inez. "That is not a topaz, but a yellow variety of the precious garnet; as its color is like that of the topaz, it is called topazolite."

Inez had now finished describing the gems which she had laid out for their morning's talk. Pushing the tray aside, she seated herself, and an animated conversation ensued, in which, at Tom's request, she related many of her experiences in the work of adding to her collection.

"Well, you must have enjoyed it," said Tom, at length. "I am sure I would."

"Enjoyed it more than your father did, perhaps," said Fritz. "It must have cost him a pretty penny. You didn't get all these stones out of your pin money?"

"Just wait till you own a gold mine, and you won't mind buying a few bits of shining stones like these," said Inez. "I admit, though, that the price of some of them has made papa whistle."

"You have not told us the whole story of your collection yet, have you, Inez?" asked Tom. "Our vacation is near its end, and I have enjoyed no part of it more than our *séances* with you."

Uncle Ben entered as he spoke, and listened with interest to his words.

"I am very glad you have enjoyed it," said Inez. "There is much yet to be said about the semi-precious stones, if you care to have me go on."

"And are my poor minerals to be thrown aside in favor of these bits of shining jewelry?" said Uncle Ben, with a mock sigh. "See here, boys, I am going to make a bid for your attention. To-morrow I propose a new departure. I want you to stand up in front of that cabinet and take from it any specimen you feel an interest in, and I will tell you all about it so far as my knowledge goes on the subject. How does that proposition strike you?"

"A very happy idea," said Fritz. "The very thing I would have suggested—if I had thought of it," he added.

"And here is another proposition which will, perhaps, please you best of all. Where you find duplicates of the minerals, you may set them aside as a nucleus for a collection for yourselves."

"Oh, Uncle Ben!" cried Tom. "Do you really mean that? Thank you a thousand times. I am

at a loss to know how we can ever repay you for your kindness."

"I shall be well paid if you continue your studies on the subject in the future. You certainly have given me as much enjoyment as you have received yourselves."

"Then you must have enjoyed it highly, for we certainly have," said Fritz. "I don't know when I have had a better time, and I can scarcely wait for to-morrow to make my selections."

"Had we not better start in now and make them in advance?" suggested Tom.

"No, no. I want it done on the spur of the moment," said Uncle Ben. "You must restrain your impatience until after to-morrow's sun rises."

CHAPTER XVII.

A LESSON AT RANDOM.

EARLY the following morning, and before breakfast was announced, Tom and Fritz were seated in busy conversation in the library.

"I tell you what, Fritz," said Tom, "there has been something running through my brain this last hour while I was thinking it time to get up. Our relatives here have been so kind to us that we ought to contrive some way of showing our gratitude. As it is not long till Christmas, we might make them some presents."

"I've thought of the same, Tom," said Fritz. "Another proof that two great brains run in the same channel. But I am puzzled to know what in the world we can give them. Uncle Ben is a millionaire, and has everything the heart can wish for. And it won't do to offer Inez or Eva any jewelry, for they have more jewels now than any ladies in the land. What shall we do? You are better at suggestion than I am. If you can think of something appropriate, you may count me in."

"I have noticed that Uncle Ben does not wear jewelry of any kind, except a watch-chain. Yet I see by notices in the newspapers that he is a mem-

ber of the Knights Templars, and a Mason of the thirty-second degree."

"You don't say so!" exclaimed Fritz.

"But I do say so. Isn't there the way to a suggestion in that? What do you say to presenting him with the finest Masonic watch-charm we can find?"

"Just the thing! That settles for Uncle Ben," said Fritz. "Now put your thinking-cap on again, and decide what we can give to the girls."

"It ought to be something in the line of their hobbies," said Tom. "I should suggest that we give Inez a binocular microscope."

"That will do admirably. If she has one, I have not seen it, and it fits in with her tastes. You are a marvel, Tom, for guessing out puzzles. Tell me now what we are to do for Eva."

"We ought to keep in the line of her tastes, too. She has a photographic camera, but it is old style. Suppose we buy her one of the latest and best? It will be very useful to her in her art studies."

"That settles it. It is astonishing what you and I can do when we put our heads together," said Fritz; "especially my head."

"Good-morning, boys," said Uncle Ben, entering the room at this moment. "Did you know it was time for breakfast? The family are all at the table."

"Why, it is remarkable that I have felt intimations for fifteen minutes past that some event was about to happen," said Fritz. "That is it,—breakfast."

"Did the intimation come from the stomach or the brain?" asked Uncle Ben.

"The stomach," put in Tom. "Fritz is very careful how he exercises his brain."

"Good!" cried Uncle Ben, laughing. "That is one in on you, Master Fritz. Well, come to breakfast, and then Tom can put that active brain of his to work."

It was Fritz's turn now to laugh.

"One in on you, Tom," he said, as they followed their uncle from the room.

An hour later found Uncle Ben seated at his cabinet of minerals, with Tom standing by his side and Fritz behind his chair.

"This is our guess morning," said Tom. "And here is a handsome cross, evidently some mineral, though it looks as if it had been cut. Suppose we start in on that."

"That is the idea," said Uncle Ben; "you are to choose and I am to talk. A similar suggestion has often been made to me when showing that specimen to my friends. It is a natural specimen, however, the stone being called staurolite, from 'stauro,' the Greek name for a cross. From its shape, which is that of a Greek cross, it is usually known as 'cross stone.' This specimen was obtained from Taos County, New Mexico. The Penitentes, a religious sect in that vicinity, look upon this stone with great reverence, and every member wears one around his neck. It is impossible to purchase one from them. An old man, from whom I tried to buy a beautiful specimen, said he would rather part with one of his children than the 'Santa Cruz' (holy cross), as it had

been blessed by 'Padre Gonzalez;' a fact which he said assured him a long and happy life, and protected him from all ailments and accidents. You will notice embedded in this specimen a large number of fine colored garnets, an unusual occurrence."

"That certainly adds to its interest," said Tom.

"Like me, it has the double merit of being interesting as well as handsome," said Fritz. "Now, Tom, you needn't say what you are going to; we will consider it as said. What is this stone composed of, Uncle Ben?" queried Fritz, with the design of heading off Tom's remark.

"It is a compound of silicate of alumina and peroxide of iron," said Uncle Ben; "neither very beautiful in itself."

"Like Fritz again," said Tom. "It needs imagination to make them beautiful."

"My dear Tom, you make me tired," said Fritz. "Uncle Ben, I have been looking for a duplicate."

"I am sorry I cannot oblige you. This is the only staurolite in my collection. But I may be able to get you a specimen later on."

"Here is a handsome blue mineral," said Tom. "May I ask what it is?"

"That is celestine," said Uncle Ben, "one of the ores of the metal strontium. Its principal use is in the manufacture of nitrate of strontium, a compound that produces red fire in fire-works and tableaux, as I have already told you. This particular specimen is a sulphate of strontium. It was obtained in the Garden of the Gods, Colorado."

"Why is it called celestine?" asked Fritz. "Has that anything to do with celestial?"

"Yes. The name comes from the color, which resembles the blue sky. It is derived from the Latin word for sky, *cœlestis*."

"And what is this stone cut into the shape of an apple?" asked Fritz.

"That is the so-called 'Mexican onyx,'" said Uncle Ben. "In mineralogy, it is classed as arragonite and traversite. It is worked into many ornamental forms, the specimen which you see having been cut into the shape of an apple by the prisoners at the penitentiary of Puebla, Mexico. The largest known body of Mexican onyx is located near Puebla, and there is a deposit of it a few miles southeast of Prescott, Arizona. It is usually found on the floor of a cave, in a limestone formation.

"There is an Aztec legend attached to the onyx, which says that before the advent of the Spaniards it was known as the 'Sacred Onyx,' and that any one found with it in his possession, except an Aztec prince or priest, was punished with death, which was inflicted by a legal executioner of the tribe. The Arizona variety is so translucent, and so delicately blended in colors, that, cut into slabs an inch in thickness and held up to the sunlight, the stone presents all the rich tints of a stained-glass window, while over its surface are pictured the most quaint and grotesque figures and images; landscapes like miniature mirages, faces and forms of men and beasts, outlines of buildings, mountains, and rivers,

all so distinctly lined that it requires an effort to believe that nature is the only artist that had a hand in its creation.

"Mexican onyx is, strictly speaking, not onyx at all, but belongs to the family of marbles, since it consists of lime. True onyx is composed of silica, and is a variety of chalcedony with alternate layers of different colors. It was the stone used by the ancients for making cameos, the figures being cut in the white layers, while the dark layers formed the background of the design."

"How does the sardonyx differ from the onyx?" asked Tom.

"Sardonyx, as the word implies," said Uncle Ben, "is composed of sard and onyx in alternate layers. The onyx is the color of the finger-nail, a delicate pink or light yellow, while the layer of sard is of a deep blood-red. Many ancient intaglios of sardonyx were made by the Greeks and Romans. Both sard and onyx are chalcedonies, the distinction being in their colors."

"Here is a black specimen that feels greasy," said Fritz. "What do you call this?"

"It is a substance with which you should be familiar," said Uncle Ben. "It is graphite, and, black as it appears, it is composed of nearly pure carbon, almost as pure as the diamond. This is the sub stance from which lead-pencils are made, their so-called lead being really carbon. On account of its infusibility, crucibles for melting gold, copper, and silver are manufactured from it. It is sometimes

called black lead and plumbago, and is used extensively as a lubricant, and as a paint for machinery, smoke-stacks, tin or metal roofs, etc. The mines of Cumberland, England, supplied the world with graphite for nearly one hundred years, but it is now found abundantly at localities in Massachusetts and New York, and also in Canada."

"What is this pretty cream-white rock on which some artist seems to have been at work?" asked Tom.

"That is novaculite, or the Arkansas hone-stone," said Uncle Ben. "The spray of lilies of the valley painted upon it is the work of your cousin Eva. It is obtained from Hot Springs, Arkansas, and is a silicious rock which is valuable on account of its grit or sharpening qualities. Under the microscope, it is said to show minute crystals of garnet."

"Here is a curious specimen, uncle," said Tom. "It seems to be frayed out at one end, like a rope whose strands are all loose."

"That is asbestos; this special variety being known as amianthus. It is of much interest from occurring in a mass of fibres which may be separated. Asbestos is flexible and almost infusible. The ancients possessed the art of drawing the fibres into threads and then weaving them into cloth which was capable of resisting the action of fire. Cloth of this character is frequently found on the mummies of Egypt."

"Perhaps to enable them to pass through Hades unscathed," suggested Tom.

"Perhaps. It is used at the present time at crematories, the body to be burned being wrapped in a cloth which has been thickly coated with asbestos paint, which protects the human ashes from all other matter. It has other uses, such as for packing steam-joints where a high temperature is employed, as a non-conductor of heat for boiler covers, and for filter bags in sugar refineries. It is mostly obtained from Canada."

"Ah!" said Tom, thrusting his hand deep into the cabinet. "This, no doubt, is a crystal of amazon stone, like the one you have already described to us."

"Oh, no. That specimen is apatite."

"Appetite? Then it must belong to Fritz. I heard him complaining to-day that he had lost it."

"That was before breakfast," said Fritz. "I found it again at the table."

"This is apatite, not appetite. You must acknowledge that the spelling makes a difference. It is a phosphate of lime, and the most important of all the phosphates commercially; and biologically also, since it is the universal basis of all bones and horns. When crystallized, it occurs in six-sided prisms, like the one you have in your hand. When amorphous, or non-crystalline, it is ground and used for fertilizing purposes. It is named apatite from the Greek word *apatas* (to deceive) on account of its being so often taken for other minerals. You see that it deceived you just now when you supposed it to be amazonite.

"This would be the best time, perhaps, to say something about the phosphatic rocks of South Caro-

lina and Florida, which have become of such value as fertilizers. They occur as a very porous substance, which is made up of masses of bones and teeth of reptiles, sharks, and other vertebrates. This rock is usually found in boulders or nodules, and in such abundance that since its discovery the importation of guano from Peru has almost ceased."

"Beg pardon for the interruption," said Fritz, "but won't you please explain what guano is? Is it anything like the phosphate rock in composition?"

"Guano is the excrement of sea-birds deposited on islands along the Peruvian coast and in other localities. It was formerly brought to this country and used as a fertilizer, to improve the producing qualities of poor land, but the richest deposits have been exhausted. During the reign of the Incas the birds were protected by severe laws. Any one landing on the islands during the time the birds were breeding, or who killed any of them at any time, was put to death. The bed of guano on these islands formerly averaged sixty feet thick, but was in places two hundred feet thick. The bones and feathers of the birds are found among its recent layers, but the bottom layers or older deposits exhibit the appearance of the phosphate rocks of the older formations, and are sometimes crystalline. Humboldt states that during three hundred years the birds had deposited guano of only a few lines in thickness, thus giving an idea of what an immense period of time has been required to form the total thickness of the beds."

"Here is what I call a handsome specimen," said Fritz; "this with long red crystals penetrating a bluish rock."

"I prize that specimen highly," answered Uncle Ben. "The red crystals are rubellite, the pink variety of tourmaline. The rock which they penetrate in all directions is lepidolite, or the lithia mica. The rubellite, when in fine crystals like this specimen, is employed as a gem stone, and dishonest dealers frequently palm it off as pink topaz. The lepidolite is, in its way, a fair barometer. If placed where the outside air can reach it, it will change to a beautiful lilac color if there is any moisture present in the atmosphere."

"It must be a composition like this that is used in making those French paper dolls which are said to denote the humidity of the atmosphere," said Tom. "They also change to a lilac color."

"Very likely." Uncle Ben looked at his watch. "My leisure time is up for to-day, I fear. By the way, you have not availed yourselves of the permission to select duplicates. If you will excuse me, I shall leave the cabinet at your mercy for that purpose. To-morrow you will have only Eva with you. The other members of the family will accompany me a few miles in the country on some important business. Eva will interest you, I know, for she has travelled extensively in different parts of the world, and always made sketches of objects of interest and copious notes of all that she saw."

"We have no doubt of that," said the boys to-

gether ; Fritz continuing, "and you need not fear but that we will occupy ourselves profitably to-day, with your collection to browse upon."

"And you can depend on us," said Tom, "not to select your best specimens as duplicates."

"I know I can trust you in that, or I would not give you *carte-blanche*," said their uncle, as he left the room.

CHAPTER XVIII.

EVA'S JOURNEY TO MEXICO.

On the following morning Mr. White and his family, with the exception of Eva, started at an early hour on their projected business journey, leaving their two youthful visitors to entertain themselves as they pleased, Uncle Ben saying that he had no doubt that Eva could make part of the day pass pleasantly for them.

"You can trust us to amuse ourselves," said Fritz. "When Eva is through, we can continue our duplicate hunt."

"All right, my lad," said Uncle Ben, laughing.

Shortly after the departure of the travellers, Eva joined the boys in the library, saying,—

"As we are but a small party, I have taken the liberty to send for Jessie and Estelle. I took it for granted you would not object."

"Not a bit of it," said Fritz.

"It strikes me as a very happy thought," said Tom.

"I shall take for my subject," continued Eva, "my recent trip to Mexico; first, because I have just completed several rough sketches made in that country, and, second, because I have previously told the young ladies all about my other tours. I think,

therefore, my trip to Mexico will be the most interesting to the whole party."

"Mexico, by all means," exclaimed Fritz. "It is all grist that comes to our mill in the way of travel. I know little about other countries and next to nothing about Mexico."

"You don't often find boys more like sponges than Fritz and me," said Tom. "We are ready to suck in information of all kinds."

"I hope I can give you some worth keeping. Ah! there goes the door-bell now. It must be the girls. Yes, there are their voices."

A moment after Jessie and Estelle entered the room, their cheeks rosy with their fresh morning walk.

"Good-morning," said Jessie. "I hope we have not kept you waiting."

"Not at all," said Eva. "We have just been talking over preliminaries."

"Good-morning," said Fritz. "I am glad you are going to Mexico with us. I don't know any way of making the trip a pleasanter one than by your company."

Meanwhile Tom had been exchanging greetings with Estelle in a quieter manner. The girls having laid aside their wraps, the party seated themselves around the table,—Fritz and Jessie on one side, Tom and Estelle on the other, and Eva at the head, all expectant of a pleasant hour's intercourse.

"As Fritz has said, we have concluded to make Mexico the basis of our talk to-day," said Eva.

"Of course, though, that was decided before we had a quorum, and ought to be put to vote again."

"I vote yes," said Jessie. "We have been about everywhere else with you."

"And I quite agree with Jessie," said Estelle. "Mexico let it be."

"The vote seems to be unanimous," said Eva. "Very well, then ; we will set out on our journey by steamer *via* New York and Havana, which is the route we took, Vera Cruz being our destination. With the exception of passing Sandy Hook, we had the most delightful trip imaginable ; it being particularly agreeable as we steamed along the Florida coast. The flat distant landscape, broken here and there by tall moss-covered cypress trees, was like a scene from fairy-land, and I could not resist taking some hurried sketches. These do not belong to Mexico, but to our own country ; but we may start in with them as mementos of our trip."

She spread out the sketches before them, the whole party springing up and looking at them with admiring eyes.

"How very beautiful!" cried Jessie. "I'd give worlds to possess your talent for drawing."

"And I for selecting the best points of view," said Estelle.

"Perhaps you both could if you practised," said Eva.

"Not at all ; it has to be born in one," said Jessie. "I did try ever so hard, and failed. No one has ever had the privilege of seeing my sketches except

Estelle, and they almost gave her softening of the brain. Father said the only thing I could ever draw successfully was money from his pockets. He further said I might in time learn how to draw a hand-cart or a pail of water, if I would only practise in that direction. I have not practised; I did not care to repeat my failure."

A laugh followed Jessie's story of her experience in the study of the fine arts, after which Eva continued:

"Leaving the Florida coast, the steamer headed for Havana, where we arrived early in the morning. After waiting an interminable length of time for the custom-house officer, we were permitted to go ashore, and spent most of the day viewing the city, eating Spanish dinners, and enjoying luscious blood oranges. Many of the streets are so narrow that it seemed as if they were built to aid the assassin. Yet the city has much in it that is novel and attractive; the out-door scenes are bright and lively, and we enjoyed our visit, though I was glad to get on board the steamship again in the evening.

"The captain informed us that the next port would be Progreso, in Yucatan, where, if we desired, we could stop off and take the next steamship, which would arrive two weeks later. Progreso proved to be such a dingy, dirty, sandy little place that I had almost determined to back out and keep to our original plan. But the rest of the party wished to stop, saying that there was much in Yucatan worth seeing, and after some persuasion I decided to keep them company and await the next steamer. I did not sketch

Progreso. Its progress had been too much of the backward sort, and we hastened to leave it by train for Merida, the capital of Yucatan. The distance was only thirty miles, but it took us over three hours to make the trip, the trains speeding only a little faster than an ox-team. Merida is one of the prettiest little cities in the world, and amply repaid us for our stop-over in Yucatan. The streets and public squares are well laid out, and such luxuriant foliage I never saw before. The market-place was a curiosity, and we purchased there many curios, mostly fancy baskets and grass hammocks. But I must not ask you to take my word only for the beauty of the town. Here are my sketches taken on the spot."

She spread out a series of half a dozen drawings, giving views of different scenes in Merida, pointing out the objects of interest, among them the market-place of which she had spoken. While they were observing them she went out, and soon returned with some of the objects she had purchased there.

"These are the baskets I spoke of," she said. "You can see that they are very neatly woven. The long grass of the country is well adapted to this purpose."

"The women of the country must have deft fingers," said Estelle; "that is, if this work is done by them."

"That I am not sure of. Likely enough men take a hand in it. If you are ready to proceed in our journey, I want to tell you one very curious thing

about Yucatan. This is that there is not on the surface of the whole peninsula a stream of water as large as your thumb, while there are numbers of underground rivers, called by the natives, 'cenotes.' They are reached by wells, into which the water rushes with great force, and is sucked out again on the side opposite to its entrance."

"Well, that is certainly an odd country," exclaimed Fritz. "It must have been turned upside down at some time, for all the rivers to run underground."

"A curious fact about these subterranean streams is this," said Eva. "Many of them are reached only at a depth of sixty or seventy feet. Now the surface at Merida is thirty feet above the ocean level, and the ocean is only thirty miles away. The query is, where does the water in the cenotes go? And why does not the water from the ocean flow inland, as it is thirty to forty feet higher at ocean level than the bottom of the cenotes? That is a mystery that is too deep for my philosophy. You may explain it if you can."

"Like the cenotes, it is too deep for mine," said Jessie.

"Maybe the water there is of a different sort from ours," said Fritz; "of the kind that runs up hill."

"I am not good at conundrums," said Tom, "and would like you to answer one yourself, Eva. What kind of country is it where the water all runs below the surface?"

"It is made up of a porous limestone or coral formation. All the rains sink out of sight, and there

are deep caves into which the natives descend for water."

"Then it cannot be very good for farming," said Estelle.

"No. I saw nothing growing except the 'henequin' plant, from which cordage is manufactured. Of course we only saw a little of the country."

"It is said that in old times there were great and flourishing cities in that country, of which the ruins are now buried deep in the forests. Did you visit any of these?" asked Estelle.

"No. I should have liked to; and we were invited to join a party that visited the ancient ruins at Uxmal and Chichen, but declined from the fact that the rainy season had already begun. On the arrival of the next steamship we sailed for Vera Cruz. But we did not stay long in the city of the 'true cross,' there being too much yellow fever there for our liking; so we took the first train for the City of Mexico, the Paris of this continent."

"Have you any sketches of the coast scenery or of Vera Cruz?" asked Tom.

"Here are some. Not very good ones, I fear, though they may give you some idea of the country. In Mexico we were specially attracted by the National Museum," she resumed, after they had examined her drawings. "It contains hundreds of ancient Aztec statues or idols, and precious stones, such as turquoise, emerald, and a stone that the Aztecs called 'Chalchiquitl,' are there in abundance.

This stone, Inez, who took great delight in the collection, told us was prase."

"And worthy of praise, I hope," said Jessie.

"Yes, I thought so. It is a variety of quartz of a soft velvety apple-green color, due to hornblende. There were also many agates, and specimens of jasper, carnelian, and obsidian, mostly polished and made into ornaments, such as nose-rings, ear-rings, finger-rings, bracelets, and weapons. Here are my sketches taken in Mexico. You can look at them while I go on with the description."

She spread them on the table before her interested auditors, and continued,—

"I cannot say that I am impressed with many of the customs of the City of Mexico. For instance, the law compels the owner of a hack to put the price per hour where it can be plainly seen. I hired one on which the placard read '*quatro reales per hora*' (fifty cents per hour), and was much surprised to know I had to pay one dollar instead of the advertised price. The owner of the vehicle pays the driver nothing, and you are compelled to pay him the same amount you have paid for the hack. Men selling the daily newspapers cry out '*aqui El tiempo de Mañana.*' 'Here is the *Daily Times* of to-morrow.' Just think of it! Selling to-day to-morrow's newspaper! But everything there is *mañana* (to-morrow). If you ask a servant to do something, he will answer, '*Si, Senorita, mañana.*' ('Yes, Miss, to-morrow.') A merchant, who had a yard full of orchids which were for sale, was requested to exhibit

them, that we might make a selection. He was reclining on a couch, and said, as he puffed smoke from his cigar, '*Bein mañana*' ('Come to-morrow').

"We spent half a day in the *Monte de Piedad*. It is a pawnshop run by the government, where a person may take any article of value and receive as a loan about one-half of its estimated value, the loan bearing a small interest, and a time being specified when it shall be redeemed. At the expiration of that time, if not redeemed, the interest is added to the original amount, and sixty days are set as the time when the article will be sold at public auction. If it is not in the mean time redeemed by the owner, it is auctioned off to the highest bidder. The government receives from the amount bid its original loan with interest, while all over that sum is credited to the person who pawned the article."

"What kind of articles are mostly pawned?" asked Estelle.

"Everything you can think of in the line of personal property. To begin at the bottom of the scale, I saw a pair of baby shoes. Close beside these came a pair of buckskin pantaloons gorgeously decked with bright silver ornaments. Then there were Mexican hats with heavy gold and silver cords, lace shawls, jewels of all descriptions, diamonds, sapphires, and rubies almost by the peck, immense mirrors, grand pianos, fancy furniture, in fact almost every household article, cheap and dear, that you could think of. It was at this place that Inez bought her yellow diamond and most of her emeralds, ob-

taining them at a ridiculously low price. While here a telegram from papa informed us that you," turning to Fritz and Tom, "were expected daily, and so we soon brought to an end our stay in Mexico."

"Oh, now! that was too bad," exclaimed Fritz. "If we had only known that we were spoiling your trip, we might——"

"You didn't spoil it much," interrupted Eva. "We only hurried up, and managed to see a good deal in a short time. We made brief journeys to several of the outlying cities, and to Chapultepec, the White House of Mexico, and then headed for home on the Mexican Central Railway. By the way, one of the company's freight agents told me a very amusing story in connection with this railroad. After the completion of the road to the City of Mexico, the agent noticed that Don Miguel Ochoa—a man who carried large quantities of freight to the city on the backs of mules and donkeys—was still engaged with his pack-trains, though it took seven days to complete the journey and seven days to return, while the trains went through in one night. The agent, in a conversation with him, pointed out where he could save at least one-half of his present expense by sending his goods by rail. Don Miguel saw the point, and ordered seven box-cars to the railroad side-track in his town, which he agreed to load and have ready for the train that would pass that night. When the doors of the cars were opened on their arrival in the City of Mexico the next morning, they were found to be loaded with mules, each

one having his pack of freight on his back,—a fact which proved that Don Miguel had not yet grasped the idea of freighting by rail."

After they had indulged in a merry laugh at Don Miguel's expense, Eva showed them the remainder of the sketches she had taken in Mexico. They included examples of city life, architecture, and country scenery, very neatly and effectively done, and were much enjoyed by the boys and girls of the party, Eva pointing out and describing their important characteristics.

"While passing through the city of Queretaro," she continued, "Inez purchased a handful of opals for a very small amount of money. They were not of the finest variety, though several fine gems were found among the lot." She proceeded to describe some of the minor details of her journey, much to the interest of Fritz and Tom, both of whom were eager to learn the customs of foreign lands.

"I shall certainly make a run to Mexico at some time in the future," said Tom. "It is easy to reach, and I think one should know something of his own continent before going abroad. So I will not make the grand tour till I have seen with my own eyes the land of the Montezumas."

"Are the Mexican and Spanish girls as pretty as they are often said to be?" asked Jessie.

"Not as pretty as some of ours, I am sure," said Fritz, with an admiring glance that called a flush of color to her face.

"I saw many beautiful girls in Mexico," said

Eva. "They were nearly all of a brunette type, with languishing and entrancing eyes. The picturesque, graceful lace mantilla which is worn by them gives an added charm. I cannot say so much of them otherwise. The Mexican girl both by training and inheritance is indifferent to much that interests the young women of more northern climes. She is fond of luxury, and is said to have a fiery temper, and to be much given to jealousy. She takes but little out-door exercise, and never appears in public without a chaperone. It is true of Mexican woman as it is of all woman born in southern countries, that they age quickly, and show an early decline of youthful charms."

"They are not much like the women of our glorious United States in any of these particulars," said Fritz. "Certainly not in their style of beauty, and their unpleasant habit of growing old early."

"I should think not, indeed!" exclaimed Tom, with such energy that all laughed except Estelle, on whom his eyes were fixed. She blushed instead.

"Oh, come! you must not get personal in your remarks," said Eva. "Remember that there are none but American women present. Not types of beauty, it is true, but——"

"Stop right there, Eva," cried Fritz. "You may be a good judge of Mexican architecture, but when it comes to American beauty——"

"Eva, haven't you some more of your sketches handy?" queried Jessie, with a view of changing

the subject. "You have been everywhere, and have sketched the scenery of the world."

"Why, if you care to look at them," said Eva, "here is a collection of Eastern drawings."

She opened a large portfolio, and for the next hour or two the party was employed in studying her sketches and listening to her descriptions, without a return to the subject on which the boys had grown so eloquent.

CHAPTER XIX.

THE WORLD'S GREAT DIAMONDS.

On the evening of the day in which Eva had told the story of her travels the remainder of the family returned from their journey, their greeting from those at home being as enthusiastic as though they had been absent for a month. The evening was passed in an animated conversation, in which some of the incidents of their journey were related, while Tom and Fritz had much to say on the pleasant manner in which they had spent the day.

"How shall to-morrow be occupied?" asked Uncle Ben, as bedtime approached. "It lies with you to name the subject you prefer to hear about."

"Why, as our visit is near its end," said Fritz, "and Inez has not yet told us about the great diamonds of the world, as she promised, I vote on that for to-morrow's subject. What do you say to that, Tom?"

"I'm agreeable, if Inez is. The big diamonds for me."

"Why, certainly, if you wish it," said Inez. "The story of some of those great diamonds reads almost like a fairy tale; but I shall have to ask you to wait till afternoon, for, of course, I do not remember it all, and will have to look the matter up in my books. I

can promise you something more than a dry talk about carats, and a series of adjectives such as sparkling, glittering, and the like."

"I have no doubt of that," said Tom. "You know how to combine pleasure with profit. Had we not better invite Jessie and Estelle to join the party? They were present when you promised the talk on diamonds."

"And will serve as living examples of the sparkling and glittering, I suppose," said Uncle Ben, with a dry chuckle.

"I should not like to tell them so," said Fritz. "And, besides, all the beauties of the world are not diamonds of the first water; but I should vote for their presence."

"I thought so. Good-night," said Uncle Ben.

On the afternoon of the following day the whole family assembled in the library, on whose table Inez had placed her cabinet of gems, among which were glass models of some of the more famous diamonds. Certain books of reference were laid in readiness, in case she should need to recall some fact she had forgotten.

While Inez was taking the desired models from the trays, and Tom and Fritz were looking at them with admiring remarks, the door-bell rang, and in a minute more Jessie and Estelle entered.

"I hope we are not late," cried Jessie, as she removed her hat. "I don't like to begin a story in the middle."

"You are in good time," said Uncle Ben; "we

are just at the preface." He pointed to the models which Inez was arranging. "Here is the opening of the book."

After a brief time spent in chat, the party seated themselves around the table, with Inez occupying a chair at its head, and her books and specimens before her.

"I propose to start in with a diamond in the air, if I may call it so," she said; "a sort of 'Castle in Spain' among the world's gems. I refer to the Brazilian stone known as the Braganza, which is in the treasury of Portugal, and so rigidly guarded that the gem experts of to-day find it impossible to obtain a glimpse of it. This mystery, and its preposterous size, render it very doubtful if it is a diamond at all; and it is rarely mentioned when the great diamonds of the world are spoken of. It has been named the Braganza after the ruling house of Portugal. I speak of this stone particularly on account of the interesting story of its finding. If you don't mind, I will read its story from Mawe, who wrote nearly a hundred years ago."

As they all appeared willing and anxious to hear the account, she opened one of her books and read as follows:

"'A few leagues to the north of the Rio Plata is the rivulet named Abaite, celebrated for having produced the largest diamond in the Prince's possession, which was found about twelve years ago. Three men, named Antonio de Sousa, José Felix Gomez, and Thomas de Sousa, having been found guilty of

high crimes, were banished into the interior, and ordered not to approach any of the capital towns or to remain in civilized society on pain of perpetual imprisonment. Driven by this hard sentence into the most unfrequented part of the country, they endeavored to explore new mines or new productions, in hope that, sooner or later, they might have the good fortune to make some important discovery which would obtain a reversal of their sentence, and enable them to regain their station in society. They wandered about in that neighborhood, making frequent searches in its various mines, for more than six years, during which time they were exposed to a double risk, being continually liable to become a prey to anthropophagi and in no less danger of being seized by the soldiers of the government.

"'At length they by hazard made some trials in the river Abaite, at a time when the waters were so low, in consequence of a long season of drought, that a part of its bed was left exposed. Here, while searching and washing for gold, they had the good fortune to find a diamond nearly an ounce in weight. Elated by this providential discovery, which at first they could scarcely believe to be real, yet hesitating between a dread of the vigorous laws relating to the diamonds and a hope of regaining their liberty, they consulted a clergyman, who advised them to trust to the mercy of the state, and accompanied them to Villa Rica, where he procured them access to the Governor. They threw themselves at his feet and delivered to him the invaluable gem on which their

hopes rested, relating all the circumstances connected with it. The Governor, astonished at its magnitude, could not trust to the evidence of his senses, but called the officers of the establishment to decide whether it was a diamond, who set the matter beyond all doubt.

"'Being thus by the most strange and unforeseen accident put in possession of the largest diamond ever found in America, he thought proper to suspend the sentence of the men as a reward for their having delivered it to him. The gem was sent to Rio de Janeiro, from whence a frigate was despatched with it to Lisbon, whither the clergyman was also sent to make the proper representations respecting it. The sovereign confirmed the pardon of the delinquents, and bestowed some preferment on the holy father. It is variously estimated to weigh from sixteen hundred and thirty carats to eighteen hundred and eighty carats.'"

"Will you let me say something here, Cousin Inez?" asked Tom.

"Certainly, if you do not ask more than I can answer."

"It is just this. Mr. Mawe says the stone weighed nearly an ounce, and then he gives enough carats to make more than a pound. A carat, I believe, weighs four grains, so that a stone of one hundred and twenty carats would weigh an ounce, and one of fourteen hundred and forty carats would weigh a pound."

"Why, yes, there does seem to be a mistake

there," admitted Inez. "Perhaps it is a misprint, —ounce for pound."

"It is amazing how those people with their lead-pencils and mathematics can spoil good stories," said Jesse.

"Don't you mind her, Tom," said Uncle Ben. "Stick to your figures. They are always safe things in mineralogy."

"Is that all that is known about the Braganza?" asked Fritz. "Has it always been kept out of the hands of experts?"

"So far as I know," answered Inez. "Murray, in his 'Memoir on the Diamond,' says it still remains uncut, but that Don John VI. had a hole drilled through it, and wore it suspended to his neck on gala days. There has always, from the date of its discovery, been a grave doubt of its being a diamond, and Murray further says, 'Mr. Mawe, who had attentively examined it, informed me that he considered it a "Nova Mina," or white topaz, and not a diamond.' Others think it to be a quartz crystal. If it really was a diamond, it would be worth, according to a well-known expert, twenty-eight million two hundred and twenty-four thousand dollars; but as the Portuguese government refuses to allow an expert examination of it, and as it is still in its rough state, no value can be put upon it.

"Mawe also tells a story of a negro who wrote to the Prince Regent that he had found near Villa do Principe an extraordinarily large diamond, and requested permission to present it in person. He was

escorted to Rio Janeiro by soldiers, and was there admitted to the presence of the Prince Regent, at whose feet he kneeled and presented the stone. It was sent to the treasury under guard, and was examined next day by Mawe, who pronounced it a rounded crystal of quartz. His test was, to cut a deep nick in it with a five-carat diamond. So the unlucky negro, who had expected a fortune from his find, was set adrift to find his way home at his own expense."

"Your friend Mawe used a word I have never come across," said Jessie. "He says that the three exiles who found the Braganza were in danger of becoming a prey to anthropophagi. That is a nice long word, but I'd like much to know what it means."

"'Anthropophagi' means 'man-eaters,'" said Inez. "Cannibals we generally call them, persons who eat human flesh. Among the ancient Tunis of Brazil, when the Paje, or chief, despaired of a sick man's recovery, he was by order of the Paje put to death and devoured by the tribe. When America was discovered, cannibalism was found to prevail to an alarming extent, and as late as 1866 two Brazilian officers who were exploring the Pachitea River were killed and eaten by the natives."

"A very entertaining set of natives they must be," said Fritz. "But I would rather not make part of their entertainment. So you think the Braganza is better suited to weigh sugar than to add to the charms of beauty?"

"I would not like to go so far as that," said Inez. "I have my doubts, but they don't go far enough to deny it all value."

"In what countries have the great diamonds been found?" asked Harry.

"In India, Brazil, and South Africa. Some diamonds have been found elsewhere, but none of large size. India was long the source of the celebrated diamonds, Brazil and Africa having more recently come into the field."

"Won't you go on now, Inez, and tell us something about the great real diamonds?" asked Estelle; "those which do not lie under a cloud of suspicion."

"And some of those that are strung on a story, like jewels on a necklace," said Fritz.

"Well, then, one of the largest is the diamond called the Matan, in honor of the Rajah of Matan, who is its fortunate owner. This stone was found in the island of Borneo in the latter part of the eighteenth century. Sir Stanford Raffles tells us its story in the following words,—

"'Among the larger diamonds which these mines have produced it may not be uninteresting to mention that the great diamond now in the possession of the Sultan of Matan, which has been seen and examined by Europeans, weighs three hundred and sixty-seven carats: it is of the shape of an egg indented on one side. . . . This celebrated diamond, known by the name of the "Matan" diamond, was discovered by a Dyak and claimed as a droit of

royalty by the Sultan of the country, Gurn Laya, but was handed over to the Pangeran of Landak, whose brother, having got possession of it, gave it as a bribe to the Sultan of Sukadana in order that he might be placed on the throne of Landak. The lawful prince, however, having fled to Bantam, by the aid of the prince of that country and the Dutch, succeeded in regaining possession of his district and nearly destroyed Sukadana. It has remained as an heirloom in the family for four descents, and is almost the only appendage of royalty now remaining.'

"According to Hugh Low, 'The "Matan" is as yet uncut and weighs three hundred and seventy-six carats, so that if cut and polished it would be reduced to one hundred and eighty-five and one-half carats. . . . I have been informed by a person who supposed himself to be a good judge of diamonds, that the Sultan possesses the real stone, which he had seen, but that a crystal is shown to strangers, as the Sultan, who has been already robbed of his territory, fears that the last emblem of royalty will be also taken from him by his powerful and avaricious neighbors of Pontianak.' The Matan diamond is about the size of a walnut and has a bluish tinge."

"Have other great diamonds been found in the Borneo mines?" asked Eva.

"None that I know of, though these mines are rich and of old date. Diamonds occur in several parts of India, whose mines have yielded them from a remote period."

"The mines of Golconda are the most celebrated, are they not?" asked Harry.

"Golconda, no doubt, has the credit for the finest diamonds; but, in fact, these came from other localities, and were only cut and polished at Golconda."

"Where is Golconda?" asked Tom.

"It is a fortress belonging to the Nizam, or ruler, of Hyderabad, a province of India, and one of the finest Golconda diamonds is called the Nizam, after its owner."

"Is it a very large one?" asked Estelle.

"Very large, indeed; it is one of the largest known diamonds, weighing three hundred and forty carats. It has not yet been cut, but has nevertheless been valued at one million dollars. It is in the shape of an almond. Very little is known of the Nizam diamond, as it is scarcely ever exhibited, a fac-simile or cast being shown to visitors instead."

"What is meant by the Great Mogul?" asked Uncle Ben. "I have heard that name given to a diamond which should be a monster by the weight of its name."

"It was probably the largest ever known, though it has unfortunately disappeared," said Inez. "It has either been cut up into smaller stones or has vanished in some convenient rat-hole. The date of its discovery is unknown, but was supposed to have been in the middle of the seventeenth century. It was found in the mines of Gani or Coulour, and fell

into the hands of the vizier of the King of Golconda, who was in control of the mines. His royal master being jealous of his wealth, he escaped from court with all his treasures and found his way to the capital of Shah Jehan, a celebrated ruler of the Mogul empire. Here he gained favor by his rich presents to the emperor, one of them being this famous diamond, which was named after the emperor the 'Great Mogul.'

"In Brock's translation of Bernier's 'Travels in the Mogul Empire,' we read, 'The largest diamond probably ever heard of is one mentioned by Tavernier, who saw it in the possession of Aurung-Zeb. It was about as big as a hen's egg and weighed nine hundred carats in the rough. Tavernier saw the stone in 1665, and says, "The first piece that Akel Khan (Royal Treasurer) placed in my hand was the great diamond, which is rose cut, round, and very high on one side. On the lower edge there is a slight crack, and a little flaw in it. Its water is fine, and weighs three hundred and nineteen and one-half ratis, which make two hundred and eighty of our carats, the rati being seven-eighths of a carat."' Tavernier, I should say, was a traveller and dealer in jewels, who made no less than six journeys to the East, and has much to say about the great jewels of that region."

"The stone seems to have decreased very much in size," said Fritz. "Was that after cutting and polishing?"

"Yes; before being cut, it weighed, according to

Tavernier, seven hundred and eighty-seven and one-half carats, not nine hundred, as Bernier says. The emperor placed it in the hands of a lapidary, Hortensio Borgios by name, whose work was execrable, and who reduced it to one-third its size. Instead of receiving pay for his work, he was fined by the emperor ten thousand rupees, all the poor fellow had, and was lucky to escape with his life. The stone resembled one-half of an egg, the base being plainly polished, and the balance cut into small facets, ending at the point or top with eight diamond-shaped facets all centring at the peak.

"Shah Jehan, the possessor of the great Mogul diamond, was imprisoned by his son, Aurung-Zeb, in a fortress at Agra, but was allowed to take his jewels with him. Tavernier tells us that a short time before the coronation of Aurung-Zeb, he requested his father to loan the jewels for the occasion; a request that threw the captive emperor into so violent a rage that it nearly caused his death. In his anger he called for a mortar and pestle, with which he intended to pulverize all his gems, so that his usurping son might never wear them; but his daughter, Bezum Saheb, implored him to save the jewels for herself and brother. Subsequently, however, the great diamond came into the son's possession, for it is related that when he mounted the throne he had but one jewel in his diadem. From that period all history of this mammoth gem is lost. It vanished during the sack of Delhi, and, though it is supposed to be in possession of the Shah of Persia,

this is very doubtful, as no such stone has ever been seen among the Shah's diamonds. It may have been cut into smaller stones by its finder to escape detection."

"That was not the only large stone that Tavernier saw in India," said Eva. "Although I have not read his 'Travels,' I have looked through them, and it is my impression that he tells of some other fine diamonds."

"I vote, then, for the rest of Tavernier's diamonds," cried Jessie, with enthusiasm. "Tell us what other wonderful stones he saw, Inez."

"Some writers think it was the Koh-i-noor, and not the Great Mogul, that he saw," said Inez, "for much the same story is told about both these stones. He tells us of another large diamond that he saw in Golconda, called 'The Great Table,' which has not been seen by any European since his time, and is supposed to have been divided into several pieces to destroy its identity. The same supposition, as I have said, has been made about the Great Mogul. He says, 'It is a stone which weighs one hundred and seventy-six and one-eighth mangelins, which make two hundred and forty-two and five-sixteenths of our carats. The mangelin is the weight used in the kingdoms of Golconda and Visapur, and it is equivalent to one and three-eighths of our carats. When in Golconda, in the year 1642, I was shown this stone, and it is the largest diamond I have seen in India in the hands of dealers. The owner allowed me to make a casting of it, which I sent to Surat to

two of my friends, calling their attention to the beauty of the stone, and to its price, which is five hundred thousand rupees, or seven hundred and fifty thousand livres of our own money. I received a commission from them, in case it was pure and of fine water, to offer four hundred thousand rupees for it, but it was impossible to come to terms at this price; although I believe it might have been had if they were willing to offer four hundred and fifty thousand rupees.' "

"What is the value of a rupee?" asked Fritz.

"It has always been a coin of changeable value. In Tavernier's time it was probably about the value of half a dollar of our money. To-day, the rupee of India is worth only about thirty cents."

"The rupee seems to have the same weakness as the diamond," said Uncle Ben, "that of varying in value *ad libitum*."

"But probably not in weight, as the diamond does," suggested Tom.

"Did Tavernier see any other large diamonds?" asked Estelle, showing some impatience at these interruptions.

"Yes, and purchased one that weighed one hundred and fifty-seven and one-fourth carats. This, which was called the 'Ahmedabad,' he had recut, reducing its weight to ninety-four and one-half carats, but perhaps increasing its beauty and value. He probably sold it in Persia, for all history of it has been lost since his time."

"Did he buy any others?" asked Estelle.

"Probably a number. One of these, named after him the 'Tavernier Blue,' he brought home from India in 1668 and sold to Louis XIV., with twenty-four smaller diamonds, for a sum equal to half a million of dollars and a patent of nobility. This stone weighed in the rough one hundred and twelve and one-fourth carats. It was cut by order of the king, and reduced to sixty-seven and one-eighth carats."

"Is it still among the French crown jewels?" asked Tom.

"No; it has mysteriously disappeared. It is believed, however, to be the same as an existing stone known as the 'Hope Blue.'"

"Why are these stones called the 'Blue'? Does that refer to their color?" asked Fritz.

"Yes; they are of the same beautiful blue color as the sapphire, while they have all the brilliancy of the diamond. Diamonds are found of various colors, including shades of yellow, red, blue, green, brown, and black. The yellow are of many shades, some of them surpassing in beauty every other yellow gem. Some of the red are of a deep rich tint surpassing the ruby in beauty. These are very rare and of high value. Next in rarity come the blue diamonds, those of a dark-blue shade being extremely beautiful. There are only five blue diamonds in all Europe."

"Is the Hope Blue a large stone?" asked Estelle.

"It weighs forty-four and one-half carats. Three blue stones have been spoken of as among the jew-

els of France,—the Tavernier Blue, the Hope Blue, and the French Blue. Some writers believe that there was one large blue diamond cut into three stones, and that the Hope is one of them. It was shown at the London Exposition of 1851, mounted as a medallion, with a border of small rose diamonds surrounded by twenty brilliants."

"Your friend Tavernier seems to have been very fortunate in finding valuable diamonds," said Jessie to Estelle.

"I don't claim any special friendship for him," answered Estelle. "But you know it is my way to finish with one subject before starting with another."

"Not a bad way, either," said Inez; "so I will return to Tavernier. He speaks as follows of two large diamonds which he saw in 1648,—

"'I will say, in passing, that no Viceroy of Goa ever left the country so enriched as Don Philip de Mascarenha. He had a quantity of diamonds, all stones of great weight, from ten to forty carats. But he had especially two, which he was good enough to show me when I was in Goa, one of which, a thick stone, weighed fifty-seven carats and the other sixty-seven and one-half carats, both of them tolerably pure and of good water, and cut in the Indian fashion. The report ran that the viceroy was poisoned on board ship, and it was added that his death was a just retribution for having caused so many persons to perish in the same way, especially while he was governor in the island of Ceylon. He always kept the most subtle poison at hand to make

use of, whenever he wished his vengeance to be swift. Having in this way made many enemies, who feared for themselves the fate of his victims, he was found one morning hung in effigy in Goa when I was there in 1648.'

"Tavernier further speaks of a stone weighing one hundred and three carats which was found at Raulconda, one of the most productive of the Indian mines. He purchased in 1653 a large diamond known as the 'Coulour,' a beautiful and pure stone weighing sixty-three and three-eighths carats. I think this is all I have to say concerning this noted diamond seeker."

"What do you mean by the Indian fashion of cutting stones?" asked Fritz.

"In India," said Inez, "diamonds as well as all other precious stones are cut by the lapidary so as to leave as many carats as possible, without any regard to beauty or imperfections. In India the girdle of a stone is never polished; it is simply ground rough; while the Amsterdam and London lapidaries pay as much attention to the girdle as to any other part of the stone. Experts can tell you where a stone was cut and polished at a glance."

"There is one great diamond you have not mentioned yet," said Jessie, "and the most celebrated of all diamonds. I mean the famous 'Koh-i-noor,' which I believe means 'Mountain of Light.' You may have the privilege of telling us all you know about this,—and more, if you know any more."

"Unfortunately, I do not know more than all," laughed Inez, "so I will have to keep within bounds. The Koh-i-noor is not the finest or most valuable of diamonds, though its history has given it great celebrity. Its story is one of the romances I promised to relate to you."

"Very well; we will kindly permit you to do so," said Jessie.

"Many thanks for your kindness," said Inez, bowing low. "The romance of the Koh-i-noor then, ladies and gentlemen, comes next in order."

All present arranged themselves for the promised story, with a light of expectancy upon their faces.

"Here it is in glass," said Inez, taking up one of her models. "But this is not the shape of the original, which has been cut and recut, with great waste of material, until this flat brilliant is all we have left. And it is not of the first water, having a gray tinge. You can see by the other models that there are finer stones in existence."

"The story! the story!" exclaimed Fritz.

"The story of the Koh-i-noor runs back far out of sight," began Inez. "According to tradition, it was found in the Godavery River, South India, four or five thousand years ago, and was worn by one of the chiefs of the war described in the celebrated Indian poem, the Mahabharata. It descended to one of the ancient princely families, that of the Rajahs of Malwar, and passed down through many generations until 1304, when it was taken as part of the spoils of battle from the Rajah of Malwar. Its

story before that time is very doubtful. Since then its history is well known. Sultan Baber, the conqueror of India and founder of the Mogul empire, has left on record, under date of May 14, 1526, the following account of how it came into his possession,—

"'Bikermajit, a Hindoo,' he says, 'who was Rajah of Gwalior, had governed that country for upwards of a hundred years. In the battle in which Ibraham was defeated, Bikermajit was sent to hell. Bikermajit's family and the heads of his clan were at this moment in Agra. When Humaiun arrived, Bikermajit's people attempted to escape, but were taken by the parties which Humaiun had placed upon the watch and put in custody. Humaiun did not permit them to be plundered. Of their own free will they presented to Humaiun a "peshkish" [which means a present] consisting of a quantity of jewels and precious stones. Among these was one famous diamond which had been acquired by Sultan Ala-ed-din. It is so valuable that a judge of diamonds valued it at half of the daily expense of the whole world. It is about eight mishkels. On my arrival Humaiun presented it to me as peshkish, and I gave it back to him as a present.' So much for the story of how this diamond fell into the hands of the Moguls. Humaiun was Baber's son, and succeeded him on the throne."

"I suppose, then, that the diamond had another period of rest in these strong hands?" said Uncle Ben.

"Yes, for about two centuries, after which it began a period of active history. It remained one of the most valuable gems in the imperial treasury until 1739, when Nadir Shah, the Persian conqueror, invaded India and captured the Mogul capital. Nadir is said to have got possession of the diamond by a cunning artifice. It had formed one of the eyes of the peacock of the famous 'peacock throne.' The throne was captured, but the diamond eye had vanished. Nadir was informed by one of the women of the harem that Mohammed, the dethroned emperor, wore it hidden in his turban, which he never laid aside. Nadir, therefore, offered to restore him to his dominions, making the occasion one of grand display. During the ceremony, he artfully proposed, in token of renewed friendship and reconciliation, to exchange turbans with him, an offer which Mohammed dared not refuse. Returning to his tent, the turban was carefully unfolded by Nadir and the long-sought-for gem rolled out. He gazed at it with delight, and exclaimed, 'Koh-i-noor' ['Mound of Light']."

"A pretty shrewd trick for our friend Nadir," said Fritz.

"He took the diamond to Persia, and there its tribulations began," continued Inez. "It had got into the land of assassinations and rapid changes in power. The stone remained with Nadir at Khorassan while he lived, but an assassin brought his life to an end, and his son, Shah Rokh, inherited the stone. He found it a source of endless misfortunes."

"Some others of those small kings wanted it, I suppose," said Harry.

"Yes. Shah Rokh was governor of the city of Mesha, and Aga Mohammed, one of the small kings in question, determined to relieve him of the Koh-i-noor and other famous jewels, and by a ruse captured the city of Mesha and ordered the Shah to deliver his treasures. The Shah declared that he had already disposed of them. Mohammed, who did not believe him, ordered his prisoner to be tortured, a threat which caused the Shah to yield up a large number of costly gems.

"As neither the Koh-i-noor nor an immense ruby which he was known to possess were among the jewels delivered, Mohammed ordered that the Shah's head should be shaved and encircled with a crown of plaster, into which boiling oil should be poured. The agony produced by this horrible torture succeeded in making him surrender the great ruby; but he still retained the Koh-i-noor, protesting that it was not in his possession. His health was permanently injured by this severe torture."

"I should think so," exclaimed Fritz. "It was enough to put an end to his career. If it had been me, I should have given up a mountain of stones, if I had owned them, rather than have my brains boiled in oil."

"He got rid of the Koh-i-noor soon after," said Inez. "In 1751, Ahmed Shah, founder of the Afghan empire, came to his assistance and formed an alliance with him, receiving the great diamond as the

price of his aid. On the death of Ahmed he left it to his son Taimur Shah, who, on his death in 1793, bequeathed it in turn to his son Shah Zaman. To the latter it brought misfortune. He was deposed, imprisoned, and deprived of his sight by his brother Shah Shurza-ul-Mulk. He succeeded, however, in retaining the Koh-i-noor, which he hid by embedding it in the plaster of his cell. In time the plaster crumbled away and exposed a sharp point of the gem, against which one of the prison officials scratched his hand. Looking down to ascertain what had caused the accident, he discovered the missing Koh-i-noor, which was recovered and delivered to the cruel brother."

"I hope he was repaid for his barbarity," exclaimed Jessie.

"He was. The diamond proved a 'stone of fate' to him. It was while he had it that it was first seen by an Englishman. He became so powerful that the government of England sent Mr. Elphinstone to him as an ambassador. At the reception given the English diplomat the Shah appeared in apparel glittering with precious stones, among them being the Koh-i-noor, in a bracelet on his right arm. In a short time after this, the Shah was expelled from Cabul, but succeeded in taking with him the far-famed diamond, concealed on his person. He found refuge with the Sikhs, the chieftain of whom, suspecting that the diamond was in his possession, succeeded in obtaining it from him after many prevarications on his part. The next step in the history

of the Koh-i-noor came in 1849, after the English had conquered the Sikhs and annexed the Punjaub. The treasury at Lahore was taken possession of, and the Koh-i-noor seized by the East India Company for presentation to Queen Victoria, whose hands it reached in 1850. Its vicissitudes, however, were not quite at an end. The cut stone weighed then about one hundred and eighty-six carats, but it was cut again, very wastefully, in London, and reduced to one hundred and six carats. It is now kept in Windsor Castle, a model of it being shown in the Tower of London."

"Well, the Koh-i-noor has certainly had adventures enough to write a novel upon," declared Fritz. "If ever I start in as a novelist, I think the title of my first book shall be 'The Romance and Reality of the Giant Diamond of the Shahs.' That ought to go down."

"No doubt; down to fifty degrees below zero, if you write it," said Tom. "It will be one of the heavy weights, like the diamond itself."

"You must let me see the first chapter," said Jessie. "I will advise you then whether to go on."

"And me the last," said Estelle. "I will advise you when to stop."

"All right," said Fritz; "and Tom shall read the middle, as a punishment for his sins."

"Don't lay such a heavy weight on my poor head," groaned Tom. "I'd rather go to Golconda and dig for diamonds."

"All this is very amusing, no doubt," said Uncle

Ben; "though I doubt if Fritz's story will prove a literary Koh-i-noor. But here stands Inez with her hands full of diamonds and her mind full of facts, waiting until you get through with your fancies."

"We are quite done, Uncle Ben," cried Fritz. "And by way of penance I will agree not to write the book."

"Which will relieve us from the penance of reading it," said Tom.

"You have said something of the wealth of gems owned by the court of Persia," said Harry to Inez. "Are there any other great diamonds among them?"

"Yes. Travellers describe some which may be classed among the finest gems in the world, the largest being the 'Darya-i-nur,' which is said to weigh one hundred and eighty-six carats. It is rose-cut, and some think that it formed one of the eyes in the peacock throne. The Koh-i-noor, as I have said, formed the other."

"What a glittering-eyed peacock that must have been!" said Jessie. "I wonder if there are any more of the same variety. They would be a great addition to the poultry yard."

"The diamond known as the 'Tagema,' or 'Crown of the Moon,'" continued Inez, "belongs to the Shah of Persia, and with the Darya-i-nur is set in a pair of magnificent bracelets valued at one million dollars. The Tagema weighs one hundred and forty-six carats, and is the brightest of all the stones in the Shah's possession."

"I think I should prefer the Shah's bracelet to Jessie's peacock," said Estelle.

"The Shah has treasures enough to supply us all," resumed Inez. "One diamond weighing one hundred and thirty-five carats, referred to by Murray, in 1838, in his 'Sketch of Persia,' is supposed to be among them. It is called, like the Koh-i-noor, the 'Mound of Light.' Another large diamond supposed to be in possession of the Shah is known as the 'Abbas Mirza.' It was found in 1832 among the harem jewels of Reeza Kooli Khan, and is thought by some to be a portion of the original 'Great Mogul.' When found in 1812, it had been in use in the family of a poor man for striking a light with a piece of steel, and had been considerably injured in that way."

"As Jessie and Estelle have chosen their diamonds, I shall bespeak the Abbas Mirza," said Eva. "It has the merit of being useful as well as beautiful."

"Like yourself," said Tom, bringing a blush to Eva's face and a laugh from the others.

"A very neat and fitting compliment," said Uncle Ben. "Thank you for Eva, Tom. Go on, Inez."

Inez had been looking into one of her books of reference, and resumed as follows:

"The diamond known as the 'Shah of Persia' weighs eighty-six carats, and is of the first water. It is table cut, or rather it is cut in a form to resemble a low sleigh with a curved dashboard. On it is engraved in Arabic the names, 'Akbar Shah,'

'Fat'hh Shah.' Sir R. Kerr Porter, in his 'Travels in Persia,' describes the jewels worn by Fat'hh Ali as follows: 'He was one blaze of jewels, which literally dazzled the sight on first looking at him. A lofty tiara of three elevations was on his head, which shape appears to have been long peculiar to the crown of the Great King. It was entirely composed of thickly-set diamonds and pearls, rubies and emeralds, so exquisitely disposed as to form a mixture of the most beautiful colors in the brilliant light reflected from its surface. Several black feathers like the heron's plumes were intermixed with the resplendent aigrettes of this truly Imperial diadem, whose bending points were finished with pear-shaped pearls of an immense size. The vesture was of gold tissue, nearly covered with a similar disposition of jewelry, and crossing the shoulders were two strings of pearls, probably the largest in the world. . . . But for splendor, nothing could excel the broad bracelets round his arms and the belt which encircled his waist. They actually blazed like fire when the rays of the sun met them; and when we know the names derived from such excessive lustre we cannot be surprised at seeing such an effect. The jewelled band on the right arm was called the "Mountain of Light," and that on the left the "Sea of Light." These names, of course, were derived from the celebrated diamonds contained in the bracelets.' Other Persian diamonds received such names as the 'Sea of Glory,' a beautiful white diamond weighing sixty-six carats, the 'Mountain of

Splendor,' the 'Throne,' and the 'Sun of the Sea,' which once ornamented the peacock throne at Delhi. As the rest of you have laid claim to all the other diamonds of the Shah, I suppose I shall have to content myself with the Mountain of Light and Sea of Glory."

"You are quite welcome to them, Inez," said Jessie. "We don't want to rob you of all."

"I may speak here of two large diamonds in the Turkish treasury," said Inez. "They are said to weigh one hundred and forty-seven and eighty-four carats, but have not been honored with names."

"So much for the gems of the Orient," said Harry. "How about the famous European diamonds? Some of them, I think, bear romantic stories."

"Yes, particularly the 'Sancy,' which has been called the sphinx among diamonds, from its bewildering history. It has mysteriously appeared and disappeared during four centuries, and perhaps the only way to reconcile the stories about it is to suppose that more than one diamond bore this name. Tradition tells us that Charles the Bold of Burgundy was the first European owner of this celebrated gem. He is also said to have owned the 'Austrian Yellow,' another large diamond, and to have lost them both on the battle-field when defeated and slain by the Swiss.

"A Swiss soldier picked up the Sancy and, thinking it to be a mere shining pebble, sold it for a few pence. It fell into the hands of the Seigneur de Sancy, from whom it received its name. It remained

in his family for nearly one hundred years, until Henry IV. commissioned one of his descendants, who was a captain of Swiss troops, to raise fresh recruits in Switzerland. King Henry, being without money to pay his army, borrowed the Sancy diamond to pawn to the Jews of Metz. Sancy sent it by a trusty servant, who failed to reach his destination, and for a time all trace of man or jewel was lost. Captain Sancy, having great faith in his servant, began a search for him, and discovered that the man had been killed by robbers and his body buried in the forest. When the corpse of the faithful servant was disinterred, the diamond was found in his stomach, he having swallowed it to conceal it from the robbers."

"Well, that is as romantic as some of your Indian tales," said Fritz.

"There are other stories about it, or about another diamond of the same name. One is that the Lord Sancy, when minister to the English court of Queen Elizabeth, sold her the jewel, and the inventory of the British jewels in the Tower of London, dated March 22, 1605, contains the following entry: 'A greate and riche jewell of golde, called the Myrror of Greate Brytayne, conteyninge one verie fayre table dyamonde, one verie fayre table rubye, twoe other lardge dyamonds cut lozengewyse, the one of them called the "Stone of the letter H of Scotlande," garnyshed wyth smalle dyamondes, twoe round perles fixed, and one fayre dyamonde cutt in fawcettis, bought of Suancey.' This gem was sold by

James II., during his exile, to Louis XIV. of France, and was valued in the inventory of the crown jewels in 1791 at two hundred thousand dollars. It was stolen in the great robbery of the crown jewels of France, at the Garde Meuble, Paris, in 1792, and all trace was lost of it until 1830, when it reappeared as the property of a merchant, though where it had been in the interval no one knows."

"It certainly has had its adventures," said Uncle Ben. "What did it weigh?"

"Fifty-four carats. There is another Sancy diamond, which was sold to the Demidoff family of Russia, and is now the property of an Indian prince, so that it has got back to its native land. Some think that there were three diamonds of this name."

"You spoke of the Austrian Yellow as belonging to Charles the Bold," said Tom. "Is it also one of the stones of legend and adventure?"

"Yes. Its story seems to be mixed up with that of the Great Sancy, for we are told that it was lost, with Charles's other jewels, on the fatal field of Grandson, and found by a Swiss soldier, who thought it a piece of glass and sold it for a florin. The new owner, Bartholomew May, a citizen of Berne, sold it in turn to Ludovico Maro Sforza. By the intercession of the Fuggers, the famous bankers, it came into the Medici treasury at Florence. When Francis Stephen of Lorraine exchanged this Duchy for the Grand Duchy of Tuscany, he became the owner of the diamond, which was subsequently known as the 'Florentine' and the 'Grand Duke of

Tuscany.' Through the Tuscan duke, who became later on the consort of the Empress Maria Theresa of Austria, the diamond came into the private treasury of the Imperial House at Vienna. At the coronation of Francis Stephen as Emperor of Germany, at Frankfort-on-the-Main, the 4th day of October, 1745, the Florentine diamond adorned the crown of the house of Austria. Its estimated value varies from two hundred thousand to seven hundred and seventy-five thousand dollars."

"Why is it called the Austrian Yellow?" asked Tom.

"From its color; it being of a decided yellow or citron tint. It is cut as a double rose, faceted all over its surface, forming a star with nine rays. It weighs one hundred and thirty-nine and one-half carats."

"What comes next in the list of storied diamonds?" asked Fritz.

"The 'Pitt,' or 'Regent,' both of which names it has borne. Before cutting, this stone came next to the Great Mogul in size, it weighing four hundred and ten carats. It was found in 1701 in the Indian mines at Puteal by a negro slave, who stole it, and had a tragic career. The finder cut his leg as if by accident and, wrapping a bandage around the wound, concealed the diamond in it."

"In the wound in his leg?" asked Tom.

"No; although that is one of the stories in connection with this valuable stone," said Inez. "He concealed the diamond in the bandage and escaped

to the coast, where he gave it to the captain of an English ship as the price of his passage to a free country. It is supposed that on the voyage the negro regretted his bargain, and undertook to possess himself again of the gem by violent means; at all events, he was thrown into the sea. The English captain sold it to one Jamchund, a Parsee dealer in diamonds, for five thousand dollars. With the money thus obtained he kept up a steady debauch until he became afflicted with delirium tremens, in which state he committed suicide by hanging himself. The stolen gem had thus claimed its two victims. Jamchund subsequently sold the diamond to Mr. Thomas Pitt, governor of Fort St. George and grandfather of the celebrated William Pitt, the price being variously stated.

"Scandalous reports were set afloat to the effect that Mr. Pitt had obtained the gem by foul means. These reports being brought to his notice, he published in the *European Magazine* of October, 1710, a full statement of all the facts. In 1743 other rumors were published reflecting on Mr. Pitt in connection with this stone, and his family republished the statement of 1710.

"The Pitt diamond weighed originally, as I have said, four hundred and ten carats, which was reduced in the cutting to one hundred and thirty-six and three-fourths carats. The cutting and polishing cost twenty-five thousand dollars, and took two years' labor of the lapidary. It was purchased in 1717 by the Regent, Duke of Orleans, for the sum of six

hundred and seventy-five thousand dollars, and has since been known as the 'Regent.' It is estimated that the dust and fragments which came from it in the polishing process were sold for thirty-five thousand dollars. In the inventory of the crown jewels of France made in 1791 this stone was valued at twelve million frances, equal to two million four hundred thousand dollars of United States coin. The Regent is almost round,—one and one-sixth of an inch in length, one inch wide, and three-fourths of an inch thick."

"It has had a romantic history, certainly; and, if I am not mistaken, there is more to tell," said Harry.

"Something more," said Inez. "The Regent was among the gems stolen in the robbery of the Garde Meuble; but it was returned by the thieves, who said that it was too well known to be safely offered for sale. They therefore sent word where it was hidden and might be found."

"There is some honor among thieves, it appears," said Fritz.

"The Regent enabled Napoleon to begin his famous career, since, by pledging it to the Dutch government, he obtained funds to prosecute his military operations and establish his power. He redeemed it afterwards, and when he became emperor it was used to decorate the hilt of his sword of state. It was exhibited at the Exposition of 1855, and is pre-eminent among diamonds for symmetry of form, transparency, purity, and beauty. Here is its facsimile."

She exhibited a model of the famous stone, to the great interest of her auditors.

"The famous diamond known as the 'Orloff,'" said Inez, on resuming her remarks, "which was presented to Catharine II. of Russia by Prince Orloff, weighs one hundred and ninety-three carats. It is about the size of a pigeon's egg, and in shape is like the Great Mogul, sitting on a flat base and faceted to the peak. It is the largest and also the most brilliant diamond in the Russian crown. It is sometimes known as the 'sceptre diamond' from its position, which is just beneath the golden Russian eagle on top and in front of the crown. It has also been referred to as the 'Amsterdam diamond,' as it was purchased in that city by Prince Orloff for his royal mistress. The price paid to the Greek merchant who sold it was four hundred and fifty thousand dollars and a life annuity worth twenty thousand dollars. Its true name is said to be the 'Koh-i-tur' (Mount Sinai), it being formerly an eye of a great idol, stolen by a French deserter, and successively sold to an English captain, a London Jew, and to the Greek merchant, but recent expert authorities deny this. It is now valued at one million six hundred and forty-nine thousand dollars."

"It seems to have had an adventurous career," said Uncle Ben.

"Not as much so as another great diamond in the Russian crown, called the 'Moon of the Mountains,' and weighing one hundred and twenty carats. This

had one of the most tragic of histories, and should have been of crimson hue, from the blood shed in its cause. It is said to have been torn from the plumage of the peacock of the famous Mogul throne and carried by Nadir Shah to Persia. After his assassination, this gem was stolen by an Afghan soldier, together with other valuable gems, including an emerald of rare beauty, a fine ruby, and a magnificent sapphire called the 'Eye of Allah.' He fled with his treasures to Bassorah, where he offered his jewels for sale to an Armenian merchant.

"The Armenian, for the purpose of gaining time to raise the amount of money necessary for the purchase, told the Afghan soldier to return on the following day, when he would conclude the bargain. But the soldier became frightened and left Bassorah for Bagdad, where the Armenian found him a few days later, only to learn that the Afghan had dis posed of the jewels to a Jew for the sum of sixty-five thousand piastres (twenty-five thousand dollars) and two Arab horses. The Armenian then offered the Jew for the diamond alone double the amount that he had paid for all the jewels, but the Jew declined. The Armenian, bent on gaining the gem by fair means or foul, murdered the Jew with the aid of two of his brothers and carried off his treasures. The Afghan soldier was poisoned while in his cups on the night that the Jew was murdered, and the two bodies were sewn in a sack and dropped into the Tigris river. A quarrel ensued between the brothers for possession of the gem, which ended in

two of them being poisoned and their bodies thrown into the Tigris. The surviving brother sold the stone to the Russian government for a very large sum and a patent of nobility. The Armenian was poisoned by a son-in-law in Astrakhan, and thus the tragic history of this stone came to an end."

"It certainly had enough victims," said Harry; "no less than five dying for its possession, all of them thieves or murderers except the Jew. By the way, you have said much about the great Indian diamonds. How about those of Brazil?"

"We could give that land the credit for the prince of gems if the Braganza were above suspicion," said Inez. "There is another great stone known as the 'Regent of Portugal'; a round gem weighing two hundred and fifteen carats and reputed to be worth one million nine hundred thousand dollars. It is said to have been found near the spot where the great Braganza was unearthed, and is frequently spoken of as the Braganza. Still another large diamond, one hundred and twenty carats in weight, decorates the crown of Portugal.

"One of the great diamonds of the world is the 'Star of the South,' which was found in 1853 in Brazil by a negro woman who was a slave at the time. It was a dodecahedron, or twelve-sided, and had an indentation in one of the facets showing that an octahedral or eight-sided crystal had fallen away from it. It weighed in the rough two hundred and fifty-four and one-half carats, and was sold for one hundred and seventy-five thousand dollars. The

cutting reduced its weight to one hundred and twenty-five carats, at an expenditure of two thousand five hundred dollars. In round numbers, it is one and three-eighths inches long, one and one-eighth inches wide, and three-quarters of an inch thick from base to point. It has a peculiarity that no other large stone possesses. Although a perfectly white stone, in some lights it gives off a rose tint. The stone was purchased by a Paris syndicate, who in turn sold it to the Gaikwar of Baroda. To him it brought misfortune, for a short time after his purchase of the great diamond he was dethroned by Queen Victoria for attempting to poison a British officer by administering diamond dust."

"He might have found some easier way of doing it," said Tom. "What would have been the effect of the diamond dust?"

"Its sharp particles would soon have caused internal hemorrhage and death."

"It would have been cheaper, I should think, to use powdered glass," said Fritz.

"In 1851," continued Inez, "a large diamond weighing one hundred and twenty and three-eighths carats was found on the river Patrocinho, Brazil, but was immediately lost sight of, and its present whereabouts is unknown. The next greatest diamond is the 'Dresden Drop,' which was found in Brazil in 1857. In its rough state it weighed one hundred and nineteen and one-half carats, which were reduced forty-three carats in the cutting, the gem now weighing only seventy-six and one-half carats. It is one

of the most brilliant diamonds known, being perfectly white and exhibiting an extraordinary play of colors. It also belongs to the Indian prince, the Gaikwar of Baroda. He is the owner of still another, fifty-one carats in weight, which was formerly worn in a necklace by the Empress Eugenie of France. After the Franco-Prussian war it was sold to the Gaikwar for a lac and a half of rupees, equal to sixty-five thousand dollars."

"If some of our officers had a search-warrant, they might find the great Mogul diamond in possession of that Gaikwar," said Fritz.

"It is not impossible that it may turn up again," said Inez. "Asia has not revealed all her secrets yet. The Gaikwar possesses another remarkable diamond known as the 'Akbar Shah,' and also as the 'Shepherds' Stone.' It is cut in the drop shape, and in its rough state weighed one hundred and sixteen carats, but was reduced by the lapidary to seventy-two carats. Before cutting, it had upon it two inscriptions in Arabic, which were unfortunately destroyed in the process of cutting and polishing. The inscriptions translated into English were, 'Shah Akbar, the Shah of the World, 1028 A.H.,' and 'To the Lord of two worlds, 1039 A.H., Shah Jehan.'"

"How would those dates correspond with ours?" asked Estelle.

"The first one, 1028 A.H., would correspond with A.D. 1650, and the latter inscription, 1039, A.H., to our year 1661, just five years before the close of the reign of Shah Jehan."

"How much did the Gaikwar pay for this stone, and from whom did he purchase it?" asked Tom.

"He obtained it from a firm of English jewellers, paying in cash four lacs of rupees (one hundred and seventy-three thousand dollars)."

"Our worthy friend the Gaikwar seems to be well provided with cash," said Fritz. "And it is certainly magnificent to serve out diamond dust for dessert."

"More magnificent than comfortable," said Jessie. "I hardly think I would care to dine with this princely lover of diamonds."

"You spoke of the 'Dresden Drop,'" said Harry. "Is there not another diamond known as the 'Dresden'?"

"There are no less than three others, known as the 'Dresden Green,' 'Dresden White,' and 'Dresden Yellow.' The Dresden Green, which is kept in the 'Green Vaults' of Dresden, is, on account of its color, one of the rarest diamonds known. It weighs forty-eight and one-half carats and is valued at two hundred thousand thalers, or one hundred and fifty thousand dollars. Of its origin nothing is known, though it is supposed to have been brought from India. The Dresden White is a remarkably brilliant white diamond of the first water, weighing thirty and three-fourths carats. The Dresden Yellow, which is also in the 'Green Vaults,' weighs thirty carats. It is very brilliant, and, as its name indicates, is yellow. The large Dresden diamond is of such pure water that, when placed by the side of

the great Koh-i-noor, it caused the latter to appear yellow by comparison."

"It turned yellow from jealousy, probably," suggested Jessie.

"A magnificent diamond was recently found in Brazil in a quartz geode about the size and shape of an egg," said Inez. "It was taken home by the finder, who was attracted by its odd shape and light weight. One day, while showing it to some neighbors, he accidentally dropped it on a stone, causing it to break into two halves. The hollow of the geode was filled with a blood-red sand, in which was the diamond, a sparkling gem.

"Mawe writes of having seen a stone weighing eighty carats of extreme brilliancy, of which nothing at present is known. It no doubt fell into timid hands, and at the proper time was cut and polished. It is now perhaps masquerading under another name, or perhaps two names, as stones are frequently broken in the cleaving process."

"In that case is the lapidary responsible?" asked Tom.

"Not justly so. Though diamonds are very hard, they are also very brittle, and they cleave easily in what are known as the cleavage planes. I may mention two more Brazilian diamonds, the 'Chapada,' of eighty-seven and one-half carats, and another weighing one hundred and five carats, found in the Das Velhas River in 1852, but which has vanished from sight."

"How about the gems of South Africa?" asked

Tom. "You have said nothing about them so far."

"Diamonds have been found there in myriads," said Inez; "some of them of great beauty and value. One of the large diamonds of the world, weighing sixty-six carats, and purchased by James Tennant, the eminent English mineralogist, a short time before his death, was found in South Africa, and originally weighed one hundred and twelve carats. Since his death this stone has been named 'The Tennant Diamond.' A stone called the 'Star of Diamonds,' found in the same district, weighs one hundred and nine and a half carats, and is said to be very brilliant and of the finest water.

"The Countess of Dudley is the owner of one of the brilliant diamonds which South Africa has produced. It had been seen in the hands of a negro before the actual discovery of the diamond fields, from whom it was purchased, and by the purchaser sold in England for fifty-six thousand dollars. It subsequently became the property of the Countess, after whom it was named 'The Dudley.' It was formerly known as the 'Star of South Africa.' In the rough it weighed eighty-three carats, which were reduced in the cutting to forty-six and a half carats. It is now worn on state occasions by the Countess as a head-piece, surrounded by ninety-five smaller diamonds.

"The diamond known as the 'Porter-Rhodes' was found at Kimberley, South Africa, on the 12th of February, 1880. In color it is blue white, weighing

one hundred and fifty carats. It is not yet cut, but is a beautiful natural crystal, and is valued by the owner at one million dollars. He has been offered three hundred thousand dollars for it. A diamond known as the 'Jagersfontein,' weighing two hundred and nine and a quarter carats, was found in South Africa in 1881 by a negro workman, and by him stolen and sold to a white man for sixty-five dollars. The white man was arrested while on his way to Kimberley, and taken back to Jagersfontein for trial. The stone was found and returned to its rightful owner, while the negro thief and white man were punished according to law. The celebrated 'Stewart' diamond found in 1872 in South Africa is a perfect crystal, having a light yellow tinge, like most of the stones found in that country. It is exceedingly brilliant. The discoverer was so elated and excited that for two days he could not be prevailed upon to eat or sleep.

"There are two named 'Du Toit.' 'Du Toit 1,' said to weigh in its cut state two hundred and twenty-four carats, and 'Du Toit 2,' of one hundred and twenty-four carats. Another South African stone, lately found, and named the 'Excelsior,' is said to be of the enormous weight of nine hundred and seventy-one carats. But of this I have only seen a newspaper account."

"If true, it is only beaten by the Braganza," said Fritz.

"Both stories sound as if they had something of the 'brag' in them," said Tom.

"Good for you, Tom," cried Harry, starting a general laugh.

"There are only a few other diamonds of which I will speak," said Inez. "The 'Pigott' belonged to Ali Pasha, who always wore it in a green silk purse which hung from his girdle. When he was mortally wounded by Reshid Pasha, he gave orders that his favorite wife, Vasilika, should be poisoned, and that the diamond should be crushed to a powder in his presence. The last order was obeyed, and now there is nothing left of the Pigott diamond except a model. I have a copy of it here." After they had examined the model, she resumed her discourse.

"A diamond weighing fifty-four carats is described in the inventory taken in 1679 of crown jewels belonging to the house of Savoy as follows: 'A large table diamond, set in gold, black and white enamelled rim; in the antique style, weighing fifty-four carats, with three appended pearls, pear-shaped, amongst which pearls is the "Pilgrim," weighing forty-five carats, the other two thirty-eight and thirty-six carats respectively. This gem was bequeathed to the crown by Queen Christina of France in her will dated April 5, 1662.'

"The 'Nassak' diamond is cut in triangular form and is very brilliant, and weighs seventy-eight and five-eighths carats. It is said to have been taken from one of the famous cave temples of India, and fell into the possession of the East India Company. It was sold at public auction in 1831 for the sum of thirty-six thousand dollars, the purchaser being an English

diamond dealer, who in turn sold it at public sale to the Marquis of Westminster, who placed it in the hilt of his sword. The stone is now reputed to be worth one hundred and fifty thousand dollars.

"The 'Hastings' diamond, which weighed one hundred and one carats in the rough, is supposed to be among the crown jewels of England.

"The 'Bazu Diamond' weighed one hundred and four carats, but had a rotten heart. When cleaned by the lapidary, eight carats of dark carbonaceous matter were taken from the centre, and it was necessary to cut it into eight pieces. It was named after a Dutchman named Bazu, and brought to Europe by Tavernier. Another notable stone, now among the Russian crown jewels, is the 'Shah,' one of the valuable gems stolen from the treasury of Nadir Shah after his death. Unlike the others, it reached St. Petersburg without a tragedy. It is a long prism, of the first water, and of eighty-six carats' weight, and is engraved with the names of three Persian rulers. It is one of the few diamonds that have been engraved."

"Well, you have certainly made yourself very entertaining and instructive, my daughter," said Mr. White; "and we certainly ought to be obliged to you for your exhaustive description of the great diamonds of the world."

"Not exhaustive," said Inez. "There are others of some note, though I know of none others that possess a story. The number of very large diamonds is not great. If we omit the 'Braganza'

and the 'Excelsior,' there are only two known diamonds—both uncut—of more than three hundred carats' weight, and seven of more than two hundred. About twenty exceed one hundred carats, and all other celebrated diamonds weigh less than one hundred carats. It was estimated some time ago that the actual number of diamonds known of over thirty carats is not more than one hundred, of which about half are in Europe. Of course, new discoveries are adding to the number."

"You spoke of the robbery of jewels at the Garde Meuble," said Tom. "It seems to have been on a large scale."

"It was the most notorious robbery that Europe has known, equalling the looting of Nadir Shah's jewel-casket," said Inez. "The Garde Meuble was a large chamber of the French treasury in which, in 1792, was kept the regalia of France, embracing a large collection of valuable gems and jewels. It was always strictly guarded, but some person or persons succeeded in entering it by climbing the colonnade of the Place Louis XV., and escaped with the plunder."

"What a daring operation!" exclaimed Fritz.

"Can you name some of the stolen jewels?" asked Estelle.

"There were three crowns and other emblems of royalty, vases of agate, amethyst, and rock crystal, the famous 'golden rose,' the Sancy, Regent, and other valuable diamonds, a splendid opal named the 'Burning of Troy,' and many other articles of value."

"Were the thieves ever discovered?" asked Harry.

"No. Some of the plunder was restored, as the robbers were afraid to offer it for sale, but the larger part of it was never regained."

"I beg pardon for seeking to break up this interesting meeting," said Eva, who had been for some time out of the room; "but with your permission I wish to announce that your presence is desired in the dining-room."

"An excellent suggestion," said Uncle Ben. "It will never do to let the dinner grow cold, even if our subject should not keep warm."

"But before we go, I wish to propose a vote of thanks to Cousin Inez for her very eloquent diamond lesson," said Fritz.

"I take pleasure in seconding the motion," said Tom.

The motion was put and carried unanimously, Inez seeking to conceal her gratification with laughter and a mock acknowledgment of the compliment, after which they all followed Eva from the room.

CHAPTER XX.

THE LAST DAYS OF THE VISIT.

At the breakfast-table, Uncle Ben handed a telegraphic despatch to Fritz with the words, "This just came to hand. You will probably be interested in its contents."

Fritz opened the paper and read as follows,—

Mr. Benjamin White,
Denver, Colorado.
Start the boys back in time to be here on Christmas Eve.
James Mayer.

Fritz, after reading it, drew down the corners of his mouth, and passed it over to Tom.

"The bolt has fallen," he said.

"I was expecting something of the kind," said Tom, after glancing over its contents.

"So was I, but not quite so soon," rejoined Fritz.

"I should like to have you stay longer, but that despatch is imperative," said Uncle Ben. "You can leave here on the night of the 20th, which will give you ample time to reach home at the appointed time. In the meanwhile the thought occurs to me that it might pay you to go with Harry to the mines which he located for you a short time since.

The three claims may be worked as one company, and Harry can arrange for developing the mines while on the ground. It will be a useful experience and a pleasant outing for you. You must think of a name for your company. Who knows but that it may become a famous bonanza sometime in the future?"

"I hope it will," cried Fritz. "I could stand the booming of a bonanza, though I am not much on names."

"Couldn't you suggest a name, Uncle Ben?" asked Tom.

"How would it do to take the last two letters from the names of each of the locators, Harry, Tom, and Fritz,—that would be Ryomtz. 'The Ryomtz Gold Mining Company.' How does that strike you?"

"Just the thing, and certainly original," exclaimed Fritz. "Hurrah for the Ryomtz Gold Mining Company. I begin to feel like a bonanza prince already, and expect to astonish the good people of Ohio with my stately airs."

"I think I shall wait till the mine shows color before I begin to put on airs," said Tom.

"It has its promise," said Harry, "though I can't say if it is rich or poor. We will set out right after dinner, as the train leaves at two o'clock. That will bring us to the mines about five. We can stay all night at the house of Pat Dolan, an old friend of my father's, and begin our prospecting in the morning."

The boys were met that evening by Mr. Dolan, who gave them a hearty Irish welcome. After supper, a bargain was made with Pat to sink a shaft on the property owned by the boys, for which they agreed to pay five dollars per foot. Harry had begun by offering Pat a one-fourth interest in the mines if he would sink a shaft on the property one hundred feet deep,—an offer which did not prove much to Mr. Dolan's liking, and brought from him a free expression of his opinion on quartz claims.

"I don't say I ain't obleeged to ye, Mr. Harry, for sich an illegant offer," said Pat, "but, to tell yiz the trooth, I wouldn't take the best quartz claim in Colorady for a gift. Sure, the divil a frind I have that ever made a cint out of one of them except your father, and he wouldn't aither, only he knows the bizness from A to Zed, being an ingineer and an assayer and everything else that's convaniant. No quartz veins for me, me boy. Give me the placer mine ivery time. Whin night comes I clean me boxes, and take out the yaller gold, and I knows to a baubee how much I made for the day. Now there's Dan Crowley and Tom Fitzpatrick, as used to be partners wid me in this placer mine, and long's the time that we made twelve dollars a day apiece. But one sorry day Dan was sthruck wid a scoientific oidea, and he said he'd find the fountain-head where all the gold come from; and Tom got bit wid the same bee, fur Dan has a mighty oily tongue of his own and clane talked him over. As I wouldn't jine hands wid 'em, they med me an offer, and I

bought their interests in the claim. Well, that was three years ago, and the divil a lie I'm telling you, but I have been grub stakin' the poor divils ever since; while I stayed here and tinded to bizness. I have a nate bank account. My wife owns a ranch and some lots in Denver, my boy Jurry is studying in the School of Mines, and my daughter Bridget will graduate in something or other at the Convent next winter. No, sir; no, Mr. Harry; no quartz veins for Pat Dolan, not if he knows hisself. But I ain't settin' out to throw cold water on your plans. I'll sink the shaft for you this winter, because the water will be frozen up and I can't work my placer mine; an' ye've got my best wishes that ye'll strike it fat. But I can't help havin' me doubts."

The contract for work on the Ryomtz Mining property was duly signed next morning, and the boys, after a close survey of the locality, left for Denver, which they reached in time for a late dinner. With the aid of Harry and their uncle they spent the afternoon in packing up the mineral specimens they had gathered and the duplicates selected from Uncle Ben's cabinet, and in the evening there was an assemblage of the family. A long talk on general subjects ensued, which ended by Tom bringing up again their late studies.

"I understand, Cousin Inez," he said, "that there is a stone for every month. That is interesting to know, and, if you will kindly furnish me with the names, I should like to make a note of it."

"Certainly," said Inez. "And each of these

month-stones, I may say, bears a special significance. Garnet is for those born in January. Its meaning is constancy. February claims the violet amethyst, which is said to bring the wearer the virtue of contentment. March is the month of the blood-stone, the meaning of which is courage. Persons born in April must wear the diamond, which is held to typify innocence. The emerald belongs to those who are born in May, and will bring to them success in love. June claims for those who are born under her balmy skies the peerless pearl, which stands for virtue. Those born in July must wear the flashing ruby, which will bring nobility of mind. August claims the moonstone, whose gift is conjugal happiness. To those who are born in September, the sapphire brings success, and prevents evil. The opal, which for a time was supposed to bring bad luck, belongs to October. It now is held to yield happiness, hope, and wealth. November claims the yellow topaz, which means that to those who wear it rightfully by reason of their birth will come fidelity and friendship. To those born in December the torquoise is said to bring a prosperous life, and to preserve from accidents."

"Did you say that the opal brought happiness, soap, and wealth?" asked Fritz.

"No; I did not know that you needed soap. If you prefer, you can exchange hope for it."

This turned the laugh on Fritz, who drew back with a wry face.

"You told us about the pearls found in American

rivers," said Tom. "I have never seen any, but there are shells in the creeks of Ohio which have the true pearly iridescence."

"And some very beautiful pearls have been found in your State," said Inez, "taken, as I told you, from the fresh-water mussels. They seem to have been more plentiful in past times than at present, for David Ingraham, who travelled in North America in 1568, wrote, 'There is in some of those countreys greate abundance of Pearle, for in every cottage I found Pearles, in some houses a quart, in some a pottell, in some a peck, more or lesse; where I did see some as great as an acorn, and Richard Browne found one of the great Pearles in a canoe or boat, wch Pearle he gave to Mouns Champlaine who toke them aboarde his shippe and brought them to newhaven in ffrunce.'"

"His pearls may have been fine," said Tom, "but his English was not much to brag of."

"Those were the days in which the schoolmaster was abroad," said Inez.

"While packing my specimens, to-day," said Fritz, "I saw one labelled lodestone or magnetic iron, and I charged my knife-blade with magnetism from it. Can you tell me anything about it, Uncle Ben?"

"It has the magnetic property of attracting iron or steel, the same as the artificial steel magnets you may have seen. Pieces of it were worn by the superstitious ancients for its supposed power of attracting friends or estranged lovers. Large quan-

tities of lodestone are sold to the negroes of the Southern States to be used as charms for 'kunjerin,' as they call it; what we call conjuring. One old negro woman living on the Bayou Teche, in Louisiana, remarked to me, 'I ain't never gwine to lose my ole man long as I done got dis kunjer stone.'"

"I also noticed, in packing the specimens, a pipe ornamented with figures labelled 'Catlinite.' That is a word which I felt like asking about."

"It is the pipestone of the Indians," said Uncle Ben, "which they have used for ages to make their pipes of. The locality in which it is found has been named after it Pipestone County."

"In what State?" asked Tom.

"In Minnesota. It is called Catlinite from the fact that George Catlin and a companion were the first white men to visit the deposit, which was jealously guarded by the Indians. It is a red stone, and was claimed by the natives to be a part of their own flesh. They fancied that if a hole were made in it by a white man the blood would flow on forever. The rocks are covered with inscriptions and paintings which have not yet been translated. The stone itself is easily cut, and could be readily worked into pipes."

"There are a few chalcedony and obsidian arrowheads in my collection," said Tom. "Has it been definitely settled how the Indians made them? I understand they had no metal tools."

"There are many theories as to how they did it," said Uncle Ben. "I have one of my own. One

day, while I was digging around an ancient Indian house near Kingston, New Mexico, I found a large number of broken arrow-heads and small shell-shaped splinters, with which were pieces of decayed wood, about the size of lead-pencils, having one end charred. It was undoubtedly the house of the arrow-maker, a man who was held in esteem next to the chief. The idea occurred to me that perhaps they set fire to one end of the wood, and, placing it against the stone, blew upon it until the rock became heated, then touched the hot spot with a drop of water. This would cause a scale of rock to snap off. I took some of the stone to my laboratory and tried the experiment, using a stick of charcoal instead of wood. I am glad to be able to say that the experiment was successful, and that I succeeded in making a fairly good arrow-head. I gave the result of this experiment to Professor Evans, an archeologist, but have no knowledge of its ever having been published."

The days that remained before that fixed for the boys' departure were occupied by Uncle Ben and Harry in taking them to the many points of interest in Colorado which they had not yet visited, they returning to Denver on the day before that on which they were to set out for home. During this day Tom and Fritz visited a number of the Denver stores and made several purchases, among which was a Masonic charm representing the thirty-second degree on one side and the Knights-Templars' degree on the other. It was composed of a red enamelled cross

surrounded by a crown, the points of which were tiny diamonds. This handsome ornament was placed in a beautiful blue-plush box, with a tag on which was written, "Tom and Fritz to Uncle Ben. Christmas, 1897." They next purchased a fine binocular microscope, and tagged that as follows: "To Cousin Inez from Tom and Fritz." "Search and you will find." Seeking a photographic supply store, they bought a fine field camera, which was labelled, "To Cousin Eva from Tom and Fritz." "May you behold many pleasant scenes through life." Their next purchase was a beautiful tortoise-shell back-comb, ornamented with sterling silver, on which they had engraved, "Tom and Fritz to Aunt Lida." All of these things were packed in a neat box and left in the express office, with positive orders given by the boys that they were not to be delivered until six o'clock on Christmas eve.

On their round through the stores they met Jessie and Estelle, who seemed very glad to see them, and equally sorry to learn that their last day in Denver had arrived. They walked together down the main business street, during which the boys, who were eager to talk over their day's doings, confided to their girl friends the story of their purchases, under strict injunctions to secrecy.

"Wild horses couldn't pull it from me," said Jessie. "But you must let me congratulate you on your presents, which are well thought of and highly appropriate."

"I think so, too," said Estelle. "It is hard to

make presents to millionaires, who are supposed to have everything already that any one could desire."

"I fear that will be our sad fate in the future," said Fritz, with a deep-drawn sigh. "Do you know what we have been doing?"

"How could we know?"

"Locating a gold mine. A shaft is to be sunk this winter, and I know that barrels of gold are awaiting us."

"Barrels of rock, no doubt," said Jessie. "But if you have our father's luck the mine won't pay your college fees. However, there is always hope."

"And always soap, which Fritz prefers to hope," said Tom. "Ask Inez if he does not."

"I can't see that he needs it," said Jessie, with an involuntary show of indignation.

Tom laughed at her tone, and looked significantly at Fritz. As the pavement grew crowded at this point, they separated into couples, Tom with Estelle and Fritz with Jessie, and began a long walk through the streets of the town, during which their conversation grew very confidential.

They parted at length near the home of the girls, Jessie saying,—

"As this is your last evening, we think you ought to repay the favor of the many days we have spent with you. We have invited Eva and Inez over for this evening, and shall never forgive you if you don't come with them."

"I should never forgive myself if I failed to come," declared Fritz.

"I always like to end a meal with a pleasant taste in my mouth," said Tom, "and I can't imagine any more charming way of ending our feast of Denver."

With a laugh at Tom's illustration, the party separated, the boys returning home.

That evening found them, according to promise, in the comfortable reception-room of their young lady friends, accompanied by Eva and Inez, a business engagement with his father having prevented Harry from attending. It was by no means their first call there, and if they had had their own way they would have preferred to come alone, though they were not impolite enough to display this feeling to their fair cousins. In truth, Fritz and Tom had been deeply stricken with the charms of the Denver belles, a feeling which seemed to be in some measure returned.

Some other young people whom the boys had met before had been invited, and the evening passed in a lively and agreeable manner, the subject of minerals and gems being absolutely forbidden, and the conversation being of the lightest and gayest character. Later in the evening games were introduced, and these were followed by refreshments, for which the hostesses had provided bonbons with amusing good-by sentiments for Tom and Fritz.

This happy thought added to the mirthfulness of the occasion, and it was near the hour of midnight when the party at length broke up, Tom and Fritz bidding good-by to Jessie and Estelle with warm

hand-pressures and looks of regret that brought a soft lustre to the eyes of their fair friends.

The next day, that of the 20th of December, found them rolling homeward as fast as a rapid express train could carry them, their minds divided between two sentiments,—that of regret at the end of their very pleasant visit, and that of pleasure at the thought of meeting their parents and home friends. With this was mingled some gratification in the thought of what they had to show and to tell, and a little disposition to boast of the fact that they were joint proprietors in a Colorado gold mine,—though Pat Dolan's opinion made them fear that it might cost more than it would yield.

Home was reached in due time and a joyful welcome given them. It was with no small pride that they unfolded and displayed the treasures they had brought, particularly as Fritz found among his a diamond and Tom a pearl which had been secretly added by Inez, together with some of Eva's most admired drawings.

In due time there came from the West letters of thanks for their very appropriate Christmas gifts, and notes of gratitude from Jessie and Estelle for little remembrances which the boys had bought and left with Inez for them.

The holiday season at an end, they returned to their studies again, and continued until spring, paying particular attention to the subject of mineralogy. Late in the spring came a letter from Harry stating that Pat had reached a promising vein in their

mine at a depth of fifty-five feet; that the vein was four feet wide, and that a mill-run of rock taken from across the vein yielded three and forty-one hundredths of an ounce per ton; or a value of seventy dollars and twenty-eight cents. Harry further stated in his letter that Pat Dolan now regretted that he did not accept his offer to sink the shaft for a quarter interest in the mine, and that the finding of this vein had created a boom in the new camp, and that speculators had surveyed and laid out a town at the foot of Inez Mountain, on Eva Creek, and the town, at the suggestion of Uncle Ben, had been named Elliottville in honor of the two girl friends of Tom and Fritz, and that it might be well for them to run out to Denver again during the summer vacation. They joyfully agreed to do so, drawn by the hope of a golden yield, but doubtless more strongly by an ardent desire to meet once more the belles of Denver.

We should be glad to report to the reader a rich output from the Ryomtz Mine, and tell the story of a brace of happy weddings in the metropolis of Colorado. But, unfortunately, we cannot lay bare the secrets of the future, and must end here our narrative of the mineral collectors' holiday.

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