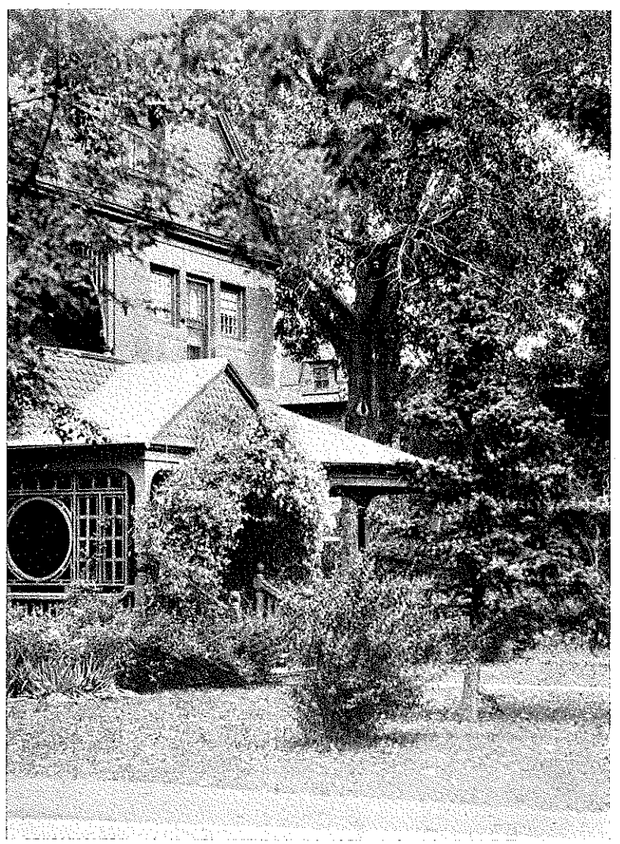
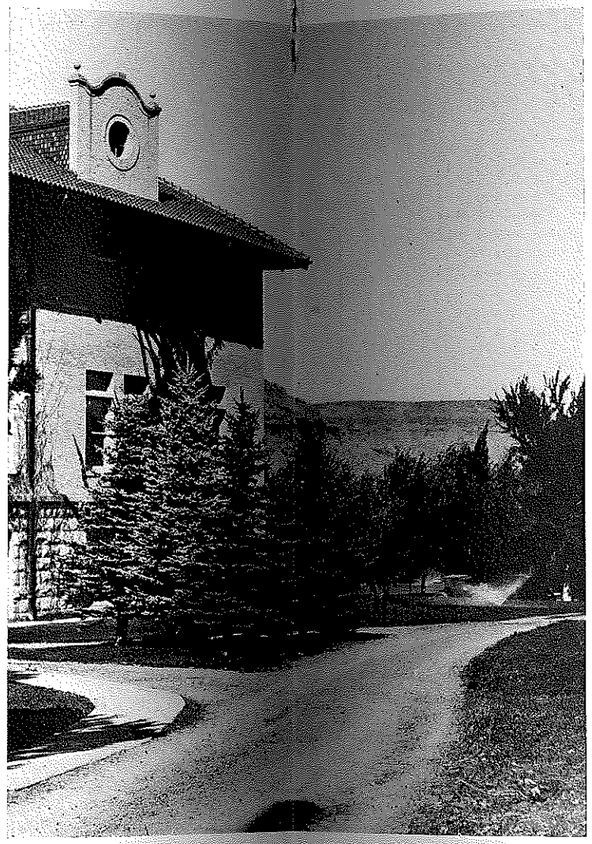
The Colorado School of Mines Magazine July 1930

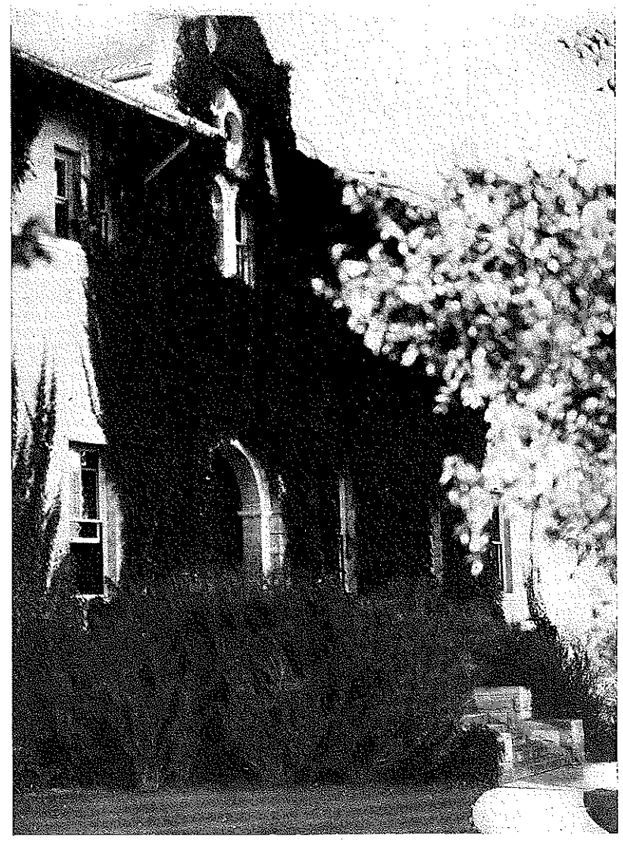
Looking at the Campus from A Different Angle



The Dean's Residence

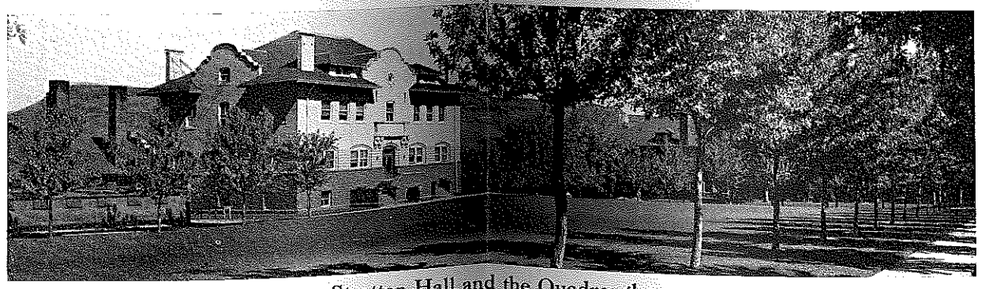


Guggenheim Hall and South Lane



Entrance to Gymnasium

ΦΔΔ Entrance



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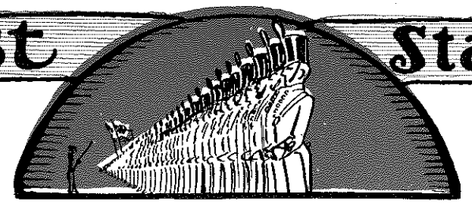

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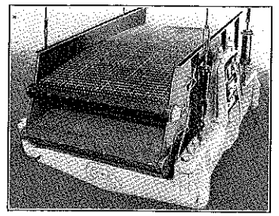

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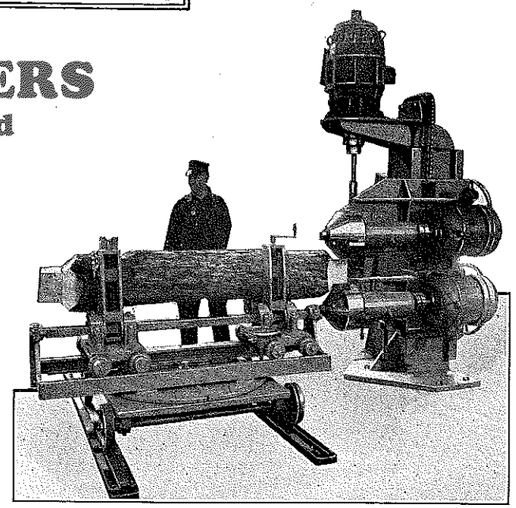

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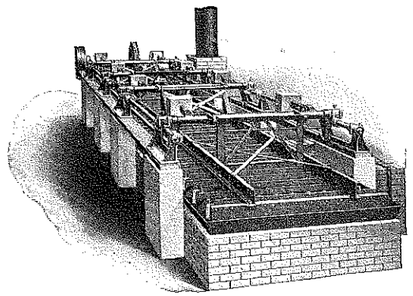

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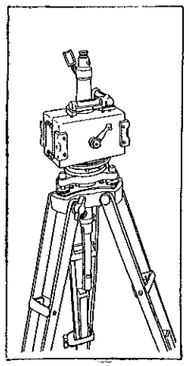

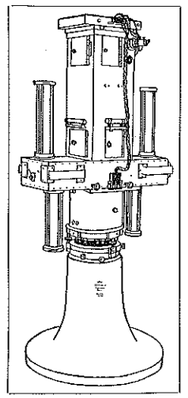

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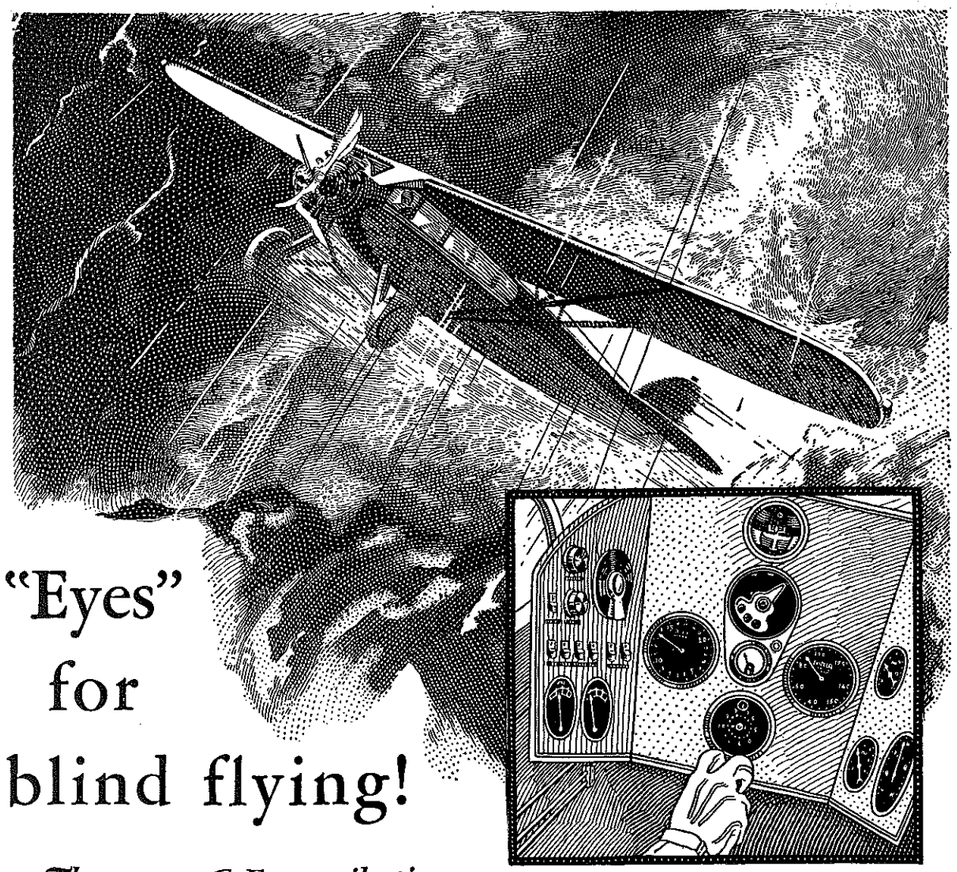

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The COLORADO SCHOOL OF MINES MAGAZINE

Twenty-five cents a copy

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Colorado School of Mines Alumni Association

One dollar and a half a year

VOL. XX — JULY, 1930 — No. 7

Published every month in the year by the Colorado School of Mines Alumni Association. Entered as second class matter at the postoffice at Golden, Colorado. Address all correspondence, including, checks, drafts, and money orders, to C. Lorimer Colburn, Secretary, Colorado School of Mines Alumni Association, C. A. Johnson Building, 509 Seventeenth Street, Denver, Colorado.

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Editorial Comment

That Vacation

SUMMER time is vacation time. Of course, some of us will be too busy to take that vacation; but most of us will put aside our work for a while, during the warm months of July and August, to do a little fishing, motoring or what-may-please-you.

There is a vacation program to suit every taste. Some prefer a week's quiet at home in the cool shade of the lawn with plenty of iced tea, lemonade—or what have you. Naturally, such a program includes books and a big, comfortable lawn swing. Others, of course, would prefer to be more active, and for these there is a program, too.

How about a trip to cool Colorado, a visit to Golden and an inspection of the Old School? There are many Alumni who have not been back to the campus for years—plan a trip to Colorado during your vacation.

The School of Mines summer session will be in progress from June 30 to August 22. It will therefore be possible to go through the School at any time during the summer. You can meet the "Prexy", the Dean and many of the professors on the faculty. Drop in on Alma Mater this summer and see for yourself what progress the largest mining school in the world is making.

Alumni, You Try It

WE cannot resist quoting here a bit of the advice given to the Seniors by Scott Turner in his commencement address. Director Turner said:

"Write technical articles. I earnestly advise it. Do not be ashamed to begin. The young engineer often feels he is not competent to write. Try it. The only way to learn to write, is to *write*. You will be astonished at how quickly you improve. It has been demonstrated that the surest way to learn everything concerning a subject is to write about it. Putting your ideas or experiences in writing tends to crystallize and clarify them. Before you can write clearly, you must think clearly. You hear much nowadays of the glories of self-expression. I urge you to apply this to your technical experiences."

To Whom the Credit?

"THERE is no limit to the good a man can do, if he cares not to whom the credit goes." This maxim has lodged in the editorial mind. We cannot recall who said it.

Selfishness, jealousy and egotism are human weaknesses. Men are jealous of their creations; their work is often a cause for boasting, and their hunger for recognition and renown frequently results in a selfish disregard of others' rights and feelings.

No one man has ever introduced an idea into this world which was entirely his own. An individual may organize facts in such a way as to bring about a new movement in industry; in the organization of society, or in the development of philosophy—But the step forward is due to a culmination of theories, facts and previous work of many individuals who have gone over the same ground before. No man is entitled to demand too much credit for putting into workable form the knowledge that many have had a hand in ferreting out of the vague unknown.

Meeting A Need

"JOURNALISM meets the first tribal need after warmth, food and women," so reads one of Kipling's epigrams. Man hungers after many things, but the most insatiable hunger of all is curiosity, and so the one half of the world is never satisfied until it learns what the other half is doing. One of the greatest moving forces in this world is the urge which human beings have to live near one another. Out of this urge grows cooperation and the need for communication of ideas.

News was first circulated by the tom-tom beat; then signal fires spread tidings; hand lettered parchments continued the process followed by crude printing presses; and now the modern miracle of the great publishing houses.

When the most primitive desires have been satisfied, the first thing one seeks is an account of what has happened to his neighbors. And so it is that men in the natural course of events come home to eat, make themselves comfortable, and then take up the newspaper, or perhaps ask the wife for an account of the day's events.

It is a common interest with one's fellows which stimulates the greatest curiosity. This curiosity is appeased only by communication among those whose interests are the same. The impossibility of communication by personal conversation, by wire, by radio or by personal letter is quite evident where numbers are involved. And so it is that all societies, organizations, and communities have their mediums of transmitting the things of common interest to all its members—Their curiosity demands it.

The Colorado School of Mines Magazine is the medium used by the Alumni of this School to communicate news that is desired to men who have at least one thing in common: namely, that all of them once attended the same college. The Magazine thus meets a *need* and that is why it is so well accepted.

Two-Fold Purpose of A Mining School *

THE tremendous importance of the mining industry is seldom realized by the average citizen. He sits comfortably at home, warmed by a modern furnace made of iron and burning coal or oil. His light is brought to him over copper wires; his water is piped into the house through iron and lead pipes—his radio, his telephone, automobile, cooking utensils, and a thousand other necessities and luxuries are all made possible by those men who discover, extract, and refine the minerals of the earth.

A Basic Industry

Mining and agriculture together produce practically all of the raw materials used in the United States. These two industries, therefore, are basic, and upon their advancement depends the general prosperity of the country. They differ essentially in the fact that the raw products of the mines are not replaceable, whereas the fertility of farm lands may be kept constant, or even increased. The natural resources upon which the mining industry is dependent can be, theoretically, exhausted; and in the same way that scientific research is being conducted in the field of agriculture to conserve the strength of the soil, so research and scientific study are being carried on for the elimination of waste in the mining industry.

Two things seem necessary to make the mining industry go far into the future. One is the necessity of discovering new ore deposits, and the other is the perfecting of processes leading to the highest possible recoveries of the low-grade ores already located. The various problems involved here are problems for trained minds. They are problems which will vary according to locality and the nature of the ores treated. General rules, therefore, are not always applicable; and the results of research, more often than not, have to be modified when applied to a particular project. Such a task requires the intelligence and specialized training of skilled engineers.

Mining Schools Have a Part

The part which the mining schools are taking in projecting the mining industry into the future is twofold. These institutions are offering to selected groups of young men the fundamental training necessary to produce skilled engineers. Second, the mining schools are encouraging research and the gathering of data upon problems that confront the mining industry in their particular localities.

It may be stated that no school of mines lays claim to the ability to graduate a thoroughly skilled engineer. The men who have finished at such institutions have been trained intensively and are equipped with the special tools needed in the solution of particular problems. They have been familiarized with the procedure used in the solution of these problems. They have, to be sure, been required to work upon these problems in the laboratory and in the field; but only experience will determine whether or not they will become skilled engineers. The Colorado School of Mines, in order to guard against the mediocre graduate, has not only strengthened its curriculum, but has been particularly careful in selecting prospective students so that the highest possible per cent of its graduates may pass this test of experience.

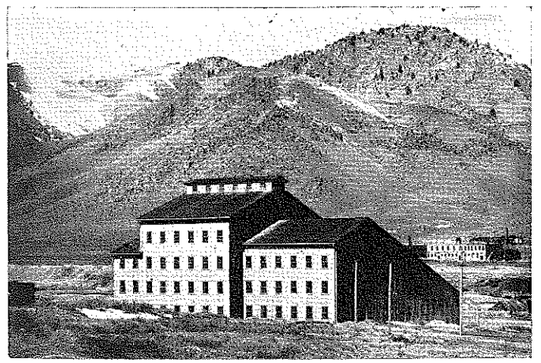
Not only is it indispensable to train men to solve particular problems, but it is necessary to formulate general working principles which offer a basis for the solution of these problems. Experiments, tests, analysis of data, and organized research, together with the publication of the results, are means of formulating such general working principles. And so it seems that the mining schools have a considerable part to play in addition to the training of men for the mineral industries.

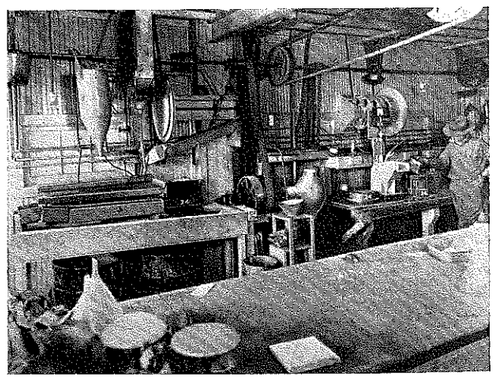
Research at the Colorado School of Mines

The Experimental Ore Dressing and Metallurgical Plant was established at the Colorado School of Mines in 1912. Many metallurgical problems confronting operators in Colorado, and other western states, have been simplified by experimentation carried on at this plant. Extensive and successful research on the flotation process has brought to this experimental plant and its present director, A. J. Weinig, a great deal of praise from all over the world. The experimentation carried on for the Climax Molybdenum Company in working out a flotation treatment for its ore serves as a splendid example of what is being ac-

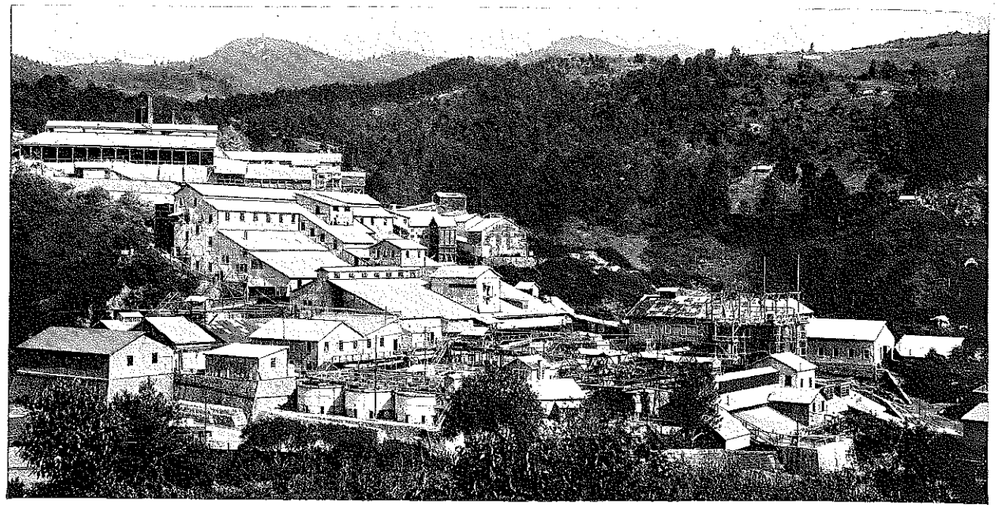
(Continued on page 28)

*—This article appeared in the April 30 issue of the *Mining Journal*, Phoenix, Arizona. Published here by courtesy of the *Mining Journal*.





Left—The Experimental Ore Dressing and Metallurgical Plant at the Colorado School of Mines. This modern milling plant is only six blocks from the center of the campus. Right—One of the testing laboratories located in the Experimental Plant. A. J. Weinig, director of the plant, is seen at work in the extreme right portion of the picture.



Modern plant used today in treating ore from the district where the Patio process was once the only metallurgy.

gold which occurs in the ratio of about 1 to 200. It has been and continues to be one of the largest silver-producing districts in the world.

The modern era of mining dates from around 1906 when the cyanide process was introduced. The three companies now operating in the Pachuca district, listed in the order of their size and importance, are as follows: Compania de Real del Monte y Pachuca, Compania de Santa Gertrudis, S. A. and the Negociacion Minera de San Rafael y Anexas, S. A. Each company has its own milling facilities. The Pachuca mills are leaders as far as modern ideas and equipment go. At present the three mills now operating handle approximately 5,800 metric tons daily, which is divided more or less as follows: Real del Monte, 3,600; Santa Gertrudis, 1,600; and San Rafael, 600. Inasmuch as the Pachuca deposit is a comparatively narrow-veined formation this daily ore extraction is remarkable in itself, and of course requires not only the most modern equipment known but also a large force of miners. The three companies employ a native personnel of approximately 12,000 including office and shop men, all of whom work under direct foreign supervision. The English-speaking colony boasts of some 350 people, of which three-fourths are American and one-fourth, British.

As the different companies operate numerous mines that are scattered over the district, the transportation and centralization of ore in such large quantities present quite a problem. A great deal of the material has been handled by aerial tramways, although the Real del Monte Company has just completed a three-kilometer haulage tunnel which will eliminate to a great extent the use of aerial trams by that company. Both the Santa Gertrudis and the San Rafael companies employ aerial tramways in their work. Until recently the Real del Monte Company operated two mills; but it is planned to dismantle one of them and increase the capacity of the Loreto mill to around 4,000 metric tons per day.

This company also operates a refinery for the whole Pachuca district, and does this work on a custom basis for other mining companies in the republic. The plant is a modern electrolytic silver and gold refinery and is the largest in Latin America.

Photo-Electric Cell Promotes Many Services

Long merely a laboratory curiosity, the photo-electric cell or electric eye, as it is more commonly called nowaday, is coming into its own by performing many useful functions that are of inestimable value to industry. For example, its watchfulness assures efficient combustion in boiler plants. From a lamp, on one side of the stack, a ray of light passes through the flue gases to a photo-electric cell on the opposite side. The opacity of the gases is measured by the amount of light that gets through, and is indicated on a meter in the fireroom. Installations of this kind have proved that the character of the flue gases is a fair gage of the firemen's skill or lack of skill and have made it possible to maintain fairly clear stacks.

In controlling factory lighting the electric eye is doing valuable work especially in reducing eye strain by turning on the lamps at the proper time. As daylight waxes and wanes, the lamps are switched off and on by the sensitive photo-electric cell. In one instance, two sections of a shop, each illuminated with lamps aggregating 8,000 watts, were controlled, respectively, by photo-electric cells and by the workers. After a three-months' test it developed that the section in charge of the workers had consumed two and a third times as much power as the area taken care of by the electric eye.

Serving for what might be called "the brain" of many devices, the photo-electric cell counts sheets of paper at the rate of 60 a second; rejects defective pieces from a moving production line; holds open the doors of automatic elevators as long as passengers are getting on or off; and turns on a fire-smothering gas when smoke, from one source or another, comes between the beam of light and electric eye. These are but a few of the present-day applications of the photo-electric cell, the possibilities of which are just beginning to be appreciated by the engineering world.

Two ways to have friends: Don't need them, own some dogs.

Principles of the Hydro-metallurgy and Electrodeposition of the Metals

V. chapter on leaching—continued

By THOMAS P. CAMPBELL*

THEORY OF LEACHING

Suppose that we have a system in which *a* moles of some molecular species, A, react with *b* moles of another species, B, to produce *m* moles of M and *n* moles of N, according to the equation

$$aA+bB=mM+nN.$$

As soon as the reactants are brought together, and, in fact, as long as there is any trace of the reactants present in the system, the velocity of reaction from left to right *at any instant* is

$$V_1=k_1(A)^a(B)^b,$$

where k_1 is a constant, characteristic of the reactants, and dependent only on temperature; and the parentheses indicate molal concentrations. Similarly, as soon as any quantity of M and N are formed, a back-reaction must set in, tending to reform A and B. Hence, again, the instantaneous velocity of reaction from right to left is

$$V_2=k_2(M)^m(N)^n,$$

k_2 being the velocity proportionality constant for the reactants.

At some instant, in the course of the proceedings, a point must be reached at which $V_1=V_2$; that is, at which the velocity of formation of the products must equal the velocity of formation of the reactants,—assuming, of course, that nothing escapes from the system. Then

$$k_1(A)^a(B)^b=k_2(M)^m(N)^n,$$

or

$$\frac{k_1}{k_2}=\frac{(M)^m(N)^n}{(A)^a(B)^b}=K.$$

This will be recognized as the familiar Law of Mass Action. The "equilibrium constant", K, is again dependent only on the temperature*; in fact, it can be shown that,

$$\frac{d\log K}{dT}=\frac{U}{RT^2}$$

where T is temperature absolute, U is the total energy change at T, and R is the gas constant. This relationship is known as the Van't Hoff Equation[30]: it indicates the fact that, as noted above, the condition of any given system is a definite function of the energy quantities involved.

This method of derivation of the Law of Mass Action is useful in that it brings out two ideas: first, that reaction velocity is a function of the concentrations of the things reacting; and, secondly, that chemical equilibrium does not represent a static condition. Incidentally, of course, the principle of reversibility is also implied; that is, chemical, or better, physico-chemical, reactions, like railroads, run both ways, and the actual motion of the train at any moment is just a matter of which end is getting the most pull.

In mechanics we are accustomed to think of *equilibrium* as a state of no motion, of rest. But in dealing with chemical systems we must conceive of a "dynamic equilibrium", a state or condition of the system in which the velocity in one direction is exactly equal to the velocity in the reverse direction. Motion *within* the system does not stop; but the resultant velocities within the system lead to a state of rest *with respect to the environment*. As viewed from the outside, no net change takes place in the system.

These considerations were developed originally for, and still apply most easily to, homogeneous systems. The quantities represented by $(A)^a$, $(B)^b$, etc., are assumed to be present in the same phase: for example, we might have $ZnSO_4$ and $BaCl_2$, each in separate solutions. Then in the first we have

$$K_1=\frac{(Zn^{++})\ (SO_4^{--})}{(ZnSO_4)},$$

and in the second

$$K_2=\frac{(Ba^{++})\ (Cl^-)^2}{(BaCl_2)},$$

where K_1 and K_2 represent the respective "ionization constants". However, on mixing the two solutions, we should also find

$$K_3=\frac{(Ba^{++})\ (SO_4^{--})}{(BaSO_4)}$$

and if this latter equilibrium produces enough $BaSO_4$ to saturate the solution, then not only does the concentration of the salt reach a fixed value, but at the same time the concentration of the unionized portion, $(BaSO_4)$ reaches a limiting value. Letting this value be represented by k′, we may write

$$(Ba^{++})\ (SO_4^{--})=K_3k'=K_s.$$

The factor k′ may be called the "solubility constant", and K_s is known as the "solubility product". For instance, $BaSO_4$ is soluble only to the extent of about 2.3 mg. per L., which is a molal concentration of about 0.00001; and since in this case k′, the concentration of the unionized salt, must be very small, we may state that K_s must be of the order of 10^{-5} moles per liter.

In dealing with leach systems we find a liquid, the solvent, in contact with a solid phase containing the solute, or at least one of its ionic constituents. Hence, except in rare cases, we may regard the concentration of one of the reactants as being fixed, insofar as ion concentrations are concerned. That is, we may look upon such heterogeneous systems as representing "unimolecular reaction" systems wherein "only one molecular species suffers an essential change of concentration".[31] And we may then represent the course of any such reaction by the relation

$$\frac{dx}{dt}=C(a-x)$$

which is simply a special form of the Law of Mass Action in which C is a coefficient characteristic of the system at constant temperature, t is time measured from the start of

* In dealing with gaseous systems, K is also dependent upon whether the reaction takes place at constant pressure or at constant volume.

[30]—Nernst, op. cit., Book IV, ch. III. Lewis & Randall, op. cit., p. 298.

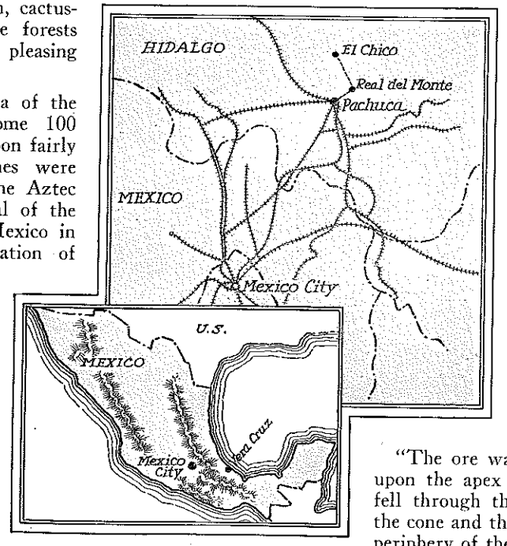
[31]—Nernst, op. cit., Book III, ch. V. Van't Hoff, Etudes de dynamique chimique (Amsterdam, 1884), pp. 13 and 113.

Silver Mining in Old Mexico—Pachuca District

Ancient Process Described by C. B. Larson, '23

By R. W. JOHNSON

SOME sixty miles northeast of Mexico City, in the State of Hidalgo, lies the world-famous silver mining camp of Pachuca. The town itself is typical of mining camps in generals, nestling at the head of a gulch from which the hills rise abruptly on three sides. From the barren, rugged and outwardly desolate appearance of these hills, which are directly adjacent to the town, it is hard for one to imagine that they contained the fabulous wealth that has been extracted from them during the past four centuries. The town of Pachuca is connected with Real del Monte and El Chico, which lie to the east, by an excellent automobile road that ascends more than a thousand feet in a few miles. The rapidity with which the vegetation changes from barren, cactus-covered hills to beautiful pine forests presents an agreeable and pleasing contrast.



The known mineralized area of the Pachuca district comprises some 100 square miles, and it is stated upon fairly good authority that the mines were worked on a small scale by the Aztec Indians long before the arrival of the Spaniards. Cortez came to Mexico in 1519 and the Spanish occupation of Pachuca dates from the year 1522. There is no question that the mineral richness of the region led to its early exploitation by these people. From the year 1522 until about the first part of the nineteenth century the camp was worked by the Spaniards who followed their usual practice of extracting only the very highest-grade ore, for in those days low-grade material could not be used; no economical means of extracting the mineral values from it had been developed. These people were hard taskmasters and exceptionally shrewd miners. They even imported convict labor from Spain to cut costs, and the native worker received only a mere pittance.

In 1557 Bartolome de Medina, a Spaniard and a Pachuca miner, invented the "patio process" of silver and gold extraction. This served so well that it was employed in treating precious ores in Mexico for more than three hundred years or until the first part of the present century when it was supplanted by the more practical and economical cyanide process. In fact, the "patio process" revolutionized the metallurgy of gold and silver ores throughout the world. A few details of this process, also called the amalgamation process, may prove of interest; so we are quoting an excellent description by Mr. C. B. Larson, who was graduated from the Colorado School of Mines in 1923, of the Safety First Department of the Compania de Real del Monte y Pachuca. His article recently appeared in *Ax-I-Dent-Ax*, a magazine that is published by the United States Smelting, Refining and Mining Company.

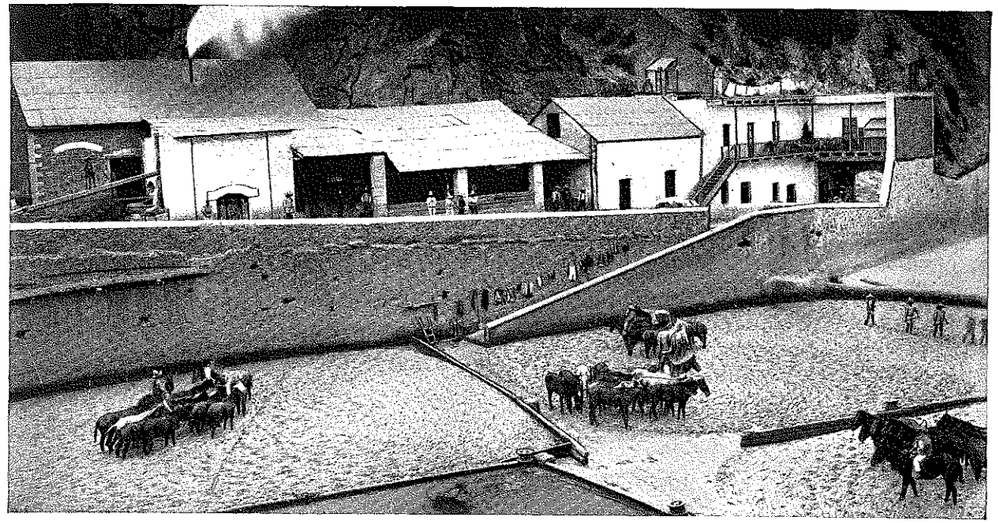
"In the early days the treatment of ores by the 'patio process' was done as follows: The largest pieces of ore were first broken by hand with sledge hammers. The next step in crushing was effected in a contrivance called the 'molino de granza,' which consisted of a circular stone tank about twenty-five feet in diameter and four feet deep. In the center was an iron cone, the sides of which were perforated and sloped down toward the outside of the tank. Two large, thick stone wheels, diametrically placed, were caused to roll around the inside periphery of the circular tank. These heavy wheels rotated upon a common axle fixed to the apex of the cone. The axle extended out beyond the sides of the tank and mules hitched to this axle furnished the motive power.

"The ore was introduced by letting it fall upon the apex of the cone. The fine pieces fell through the perforations in the sides of the cone and the coarse ore rolled down to the periphery of the tank where it was crushed by the wheels rolling over it. Men inside the tank constantly shoveled the crushed ore from the path of the wheels and threw it back upon the cone where the small pieces would fall through the openings. This crushing was done dry.

"The next step was wet grinding in the 'arrastre,' a contrivance similar to the 'molino de granza' except that large heavy rocks were used instead of the big stone wheels. These large rocks were dragged around over the ore on the bottom of the tank, grinding the ore to about eighty mesh. As the slime was run off, it was collected and stored in large tanks until three or four hundred tons of ore had accumulated. The slimes were allowed to settle and the water was decanted. The slimes were then spread to a depth of about eight inches over the stone floor of a shallow tank in the 'patio' or yard.

"A batch of ore thus spread out was called a 'torta.' It was allowed to dry for two or three days until it attained the consistency of heavy mud. Then about ten per cent by weight of salt, three per cent of copper sulphate and one pound of mercury, to approximately one pound of silver content of the ore, were distributed and mixed through the mass.

*—Published here by permission of the *Du Pont Magazine*.



Patio Process, ancient method used in Mexico for recovering values from silver ore. The tramping of the horses mixes the slime.

"A band of horses was now turned in and driven around over the 'torta' for several hours each day, their hoofs keeping the ore stirred up to aid the amalgamation. About every other day the 'torta' was spaded up to insure complete mixing. Each day handfuls of ore were grabbed at random from different places around the 'torta' and the amalgam from these samples was collected into a button and examined to determine its condition, which indicated whether or not the chemicals were in correct proportion. From time to time more salt, copper sulphate and mercury were added. When the tests showed the amalgamation to be as complete as possible—usually after about thirty or forty days of such treatment in the 'torta'—the clean-up was begun.

"The mass was then loaded on sleds and hauled to the 'lavadero,' a stone tank about twenty feet square, having several inches of mercury in the bottom. As the product from the 'torta' was thrown into the tank, several men inside, by means of their bare feet and shovels, mixed it with the mercury in the bottom of the tank. At the same time water was kept running over the mixture, thus washing the rock into long riffled launders. Catch pits filled with mercury were also located at intervals along the launders. The amalgam that was not caught in the 'lavadero' was recovered in the rifles and catch pits. After the clean-up the amalgam was put into a large canvas bag and as much pure mercury as possible was squeezed out through the canvas, leaving the more concentrated amalgam which was then retorted.

"In the very early days no attempt was made to separate the gold from the silver in the bullion. Due to this the old silver coins once contained considerable gold. In more recent times the bullion was parted and the ponderous old 'molinos de granza' and the 'arrastres' were supplanted by jaw crushers, Chile mills and stamps. The bands of horses, which were driven over the ore to stir it up, were also replaced by gang plows attached to electrically-driven frames which moved on rails.

"The maximum extraction of silver obtained by the old 'patio process' was around ninety per cent but the gold extraction was lower. This process was still in use at Pachuca until about 1905. The ancient walls that surrounded the 'patio,' where the Bartolome de Medina process used to be carried on, now echo with the roar of a large, modern mill."

Another interesting incident of the Spanish occupation was the purchase in 1739 of the main Real del Monte mine by Pedro Jose Romero de Terreros, a muleteer, for the consideration of 60,000 pesos. By the year 1781 Terreros had taken from this property over fifteen million pesos, and in compensation for the gifts of fabulous value he presented to the King of Spain, he was awarded the title of Count of Santa Maria of Regla. Shortly after 1781 his mine became flooded and due to the lack of adequate pumping machinery it was abandoned.

About 1800 this mine was examined by a mining engineer who carried to London most extravagant stories of the wealth of the property to be had for the unwatering of it. Due principally to the reports presented by this engineer there was formed in London around 1824 the famous Real del Monte Company. That same year about 350 Cornish miners and two shiploads of machinery were sent to the property. All the equipment was unloaded at Vera Cruz and packed by mule and man power up the mountains to Pachuca and Real del Monte. This was a hard task because the distance between these points is approximately 500 kilometers and embodies an ascent from sea level to an elevation of more than 10,000 feet.

The following year, in spite of the fact that the mines were still under water and in a lamentable condition, speculation in this company's stock reached prodigious levels. It is said that 100 shares of a par value of 100 pounds sterling were sold for as high as 16,000 pounds. After approximately a quarter of a century of operation, the company went into liquidation, having made a gross outlay of some four million pounds for a return of about three millions. The mines were sold in 1848 to a local Mexican company at a very low figure and shortly afterwards the famous Rosario vein was cut and the company thrown into bonanza. It is estimated that this vein has yielded more than eighty million pesos.

Although no exact production figures are available, it has been estimated that the Pachuca region has yielded to date over 600 million ounces of silver, not to mention

the reaction, a is the "dissolving power" of the solution, and x is the amount of the solvent reactant used up in time t. At the start, t=O and x=O. Then by integration and conversion to $\log_{10}$, we have

$$t=\frac{2.3}{C}[\log(a)-\log(a-x)],$$

and from this it is evident that

$$\frac{2.3}{C}\log 2=t'$$

is the time required for half of the potential dissolving power of the solution to be used up: i.e., for x=a/2.

EXAMPLE: A gold ore contains 1.43 oz. Au per dry ton. It is leached with a solution containing 0.01% free NaCN (0.2 lbs. NaCN per ton soln.), and five tons of solution are applied to each dry ton of ore. After 24 hours leaching, the ore still contains 0.94 oz. per dry ton. How many hours leaching would be required to dissolve all the Au?

The five tons of solution contain 1 lb. free NaCN. This weight of NaCN should dissolve 2 lbs., or 29.15 troy oz., of Au, according to the reaction,

$$2Au+4NaCN+O+H_2O=2NaAu(CN)_2+2NaOH.$$

Hence the dissolving power of the solution, a, is 29.15. At the end of 24 hours, the gold extracted from the ore is 1.43—0.94=0.49 oz.; that is, the dissolving power of the solution has been diminished by x=0.49 oz. Therefore,

$$24=\frac{2.3}{C}[\log 29.15-\log(29.15-0.49)]$$

and

$$K=\frac{2.3}{C}=3261.$$

And the time required to make x=1.43 is

$$t=3261[\log 29.15-\log(29.15-1.43)]$$
$$t=71.25 \text{ hours.}$$

It will be noticed that this relation is identical in form and significance with that used in the chapter on roasting. In fact, leaching and roasting reactions are almost identical from the standpoint of kinetics. Thus, just as in the case of a small solid particle reacting with a gaseous medium, so in the case of leaching we may list the factors influencing the rate of reaction:[32]

1. Physical nature or condition of the matter to be dissolved; ratio of surface to mass.
2. Velocity of diffusion of the ionic constituents in the solution to and from the solid surface.
3. The concentration of the solvent reagent, or "strength of the solution".
4. The rate of change of relative position between particles of solid and adjacent solvent.
5. Temperature.

The mechanism of dissolution would thus appear to be, first, the reaction of the solvent with the substance to be dissolved at the surface of the solid particle, forming a layer of practically saturated solution at or near that surface. Second, this saturated solution must diffuse into the main body of the solvent, or be swept away from the surface by artificial means, before more reactive solvent can attack the next underlying solid surface. The equation deduced above applies strictly to the reaction taking place at the *surface,* but does not account for the diffusion rate. However, if the pulp is subjected to uniform agitation at constant temperature, the application of this equation becomes valid and useful if it is understood that a diffusion factor is necessarily included.

[32]—Liddell, Handbook of Chem. Eng., vol. I, ch. IX; N. Y., 1922.

If there were no agitation of any sort, the reaction rate *as observed* would be determined almost wholly by the natural diffusion of the ions of the solution. The rate of this diffusion, in turn, would be a function of the osmotic pressures of the various ions involved[33]. But in practice it is the invariable custom to provide for some sort of relative motion of solids and liquids, so that we need not concern ourselves with the problem of osmosis from the quantitative standpoint at this time.

Referring again to the equation for rate of reaction, it will be seen that if we could arrange our leaching system in such a way that the solids and liquids could move *counter-current* to each other, we should be able to shorten the time required for leaching, since in this way we would bring the strongest solvent into contact with the weakest, or most nearly leached, solid, and vice versa. It will be recalled that this practice is also followed in oxidizing roasting: raw ore, or concentrate enters at the top of the furnace, and fresh air enters at the bottom; thus gases and solids travel counter-current thru the furnace.

However, liquids are considerably more viscuous than gases; therefore, the settling rate of a solid thru a liquid is relatively slow, and a simon-pure counter-current leach is not always possible. However, as will be shown in the next section, several arrangements which approximate to such a condition are both possible and practicable.

Again, as noted under roasting, increase in temperature increases the rate of all chemical reactions. In the case of roasting, the upper limits of temperature were defined by sintering, production of insolubles, and fuel costs. In the case of leaching reactions, the upper limit of temperature is the boiling point of the solvent, in most cases, insofar as the technician is concerned. In some instances,—for example, alkali cyanide solutions,—too high a solution temperature leads to decomposition either of the solvent reagent proper, or of the reaction product. Another point worth remembering is that rise of temperature increases the speed of all reactions, both beneficial and harmful, in the system.

In practice, therefore, the upper limit of temperature is again dictated by expediency, the cost factor being, as a rule, the major consideration.

Finally, as to the choice of solvent: The ideal solvent would be one that is highly selective in action, safe and easy to handle, inexpensive, and one that causes little or no deterioration of equipment. Needless to say, "there ain't no sech animal"; but with some care and forethought it is usually possible to pick a solvent that will meet at least some of these conditions. Many plants have been ruined, physically and financially, simply because the improved metallurgical results attainable with a certain solvent were allowed to obscure the prospects of high maintenance costs, danger, and rapid plant deterioration brought about by the use of that solvent.

In some cases, of course, the choice of solvent is limited; in such cases, the success or failure of the enterprise must hinge upon the ability to provide against failures, accidents, and corrosion incident to the use of a particular solvent.

Again, many failures have resulted from a lack of knowledge of the elementary chemistry of the reactions taking place in a given process. It is impossible, in the present state of our knowledge, to predict all of the woes and tribulations which may be inherent in even a relatively simple process. But that should not preclude the application of what knowledge we do possess, nor excuse the employment of "rule of thumb" methods exclusively. When

[33]—Nernst, op. cit., p. 161.

mistakes are made on a small scale, profits are more apt to accrue on a large scale.

It is not within the scope of this work to take up a detailed discussion of the inorganic chemistry of leaching reactions; but in concluding this section it may not be amiss to indicate, by one or two examples, some of the more important principles involved.

Oxidation and Reduction

By *oxidation* is meant the loss of electrons, or the gaining of one or more positive charges.[34] Thus, if metallic copper is taken into solution as $CuSO_4$, the Cu must lose two electrons to form Cu^{++}; therefore the copper must be oxidized. Conversely, *reduction* implies the addition of electrons. Then obviously, oxidation and reduction must be complementary processes; there cannot be an oxidation without a corresponding reduction,—just as every action requires an equal and opposite reaction. For example, the reaction

$$Zn+H_2SO_4=ZnSO_4+H_2$$

may be written in the form

$$Zn+2H^++SO_4^{--}=Zn^{++}+SO_4^{--}+H_2.$$

This brings out the fact that Zn has been oxidized at the expense of hydrogen ion; and, by the same token, hydrogen ion has been reduced by zinc. Hence, in this case, hydrogen ion acts as an *oxidizing agent,* and zinc acts as a *reducing agent.* In short, then, whether a given substance acts as an oxidation or reduction agent depends upon its willingness to swap electrons with some other substance. And the quantitative measure of this condition is given by the order and potentials of the elements in the electromotive force series; a partial list of which is given below[35]:

Reduced State	Volts Potential	Oxidized State
K	—2.9224	K^+
Na	—2.7125	Na^+
Zn	—0.7581	Zn^{++}
Fe	—0.441	Fe^{++}
Cd	—0.3976	Cd^{++}
Sn	—0.136	Sn^{++}
Pb	—0.122	Pb^{++}
Fe	—0.045	Fe^{+++}
Pt/H_2	0	H^+
Cu	+0.3448	Cu^{++}
Hg	+0.7986	Hg^{++}
Ag	+0.7995	Ag^+
Pt/S^{--}	+0.51	S (rhomb.)
Pt/OH^-	+0.3976	O_2
Pt/I^-	+0.5375	I_2 (solid)
Pt/Br^-	+1.0659	Br_2 (liquid)
Pt/Cl^-	+1.3594	Cl_2 (gas)

The sign before the potential is that assumed by the metal in contact with a solution which is molal with respect to its ion. Any element will reduce any other element below it; therefore the left-hand column gives the order of the elements as reducing agents, and the right-hand column their order as oxidizing agents. For example, the familiar reaction

$$Zn+Cu^{++}+SO_4^{--}=Zn^{++}+SO_4^{--}+Cu$$

shows that the Cu loses two positive charges, or gains two electrons per atom, while the Zn loses two electrons per atom. Hence the Cu^{++} is reduced by the Zn. From the table of potentials above, it is seen that the total potential required to bring about this change is

$$E_o=0.3448-(-0.7581)=1.1029 \text{ volt;}$$

hence, if we could arrange this system in such a way that it could perform useful work upon the surroundings,—as in the familiar Daniel Cell,—we could derive 50,896 calories per gm.-mole or 91,543 B.t.u. per lb.-mole involved at 25°C.,—which is the "free energy" of the reaction. From the technical standpoint, the important consideration brought out is that this reaction will proceed most readily in a *reducing medium.*

As another example, the reaction

$$2Fe_2(SO_4)_3+CuFeS_2=5FeSO_4+CuSO_4+2S$$

may be written in the form

$$4Fe^{+++}+Fe^{++}+2S^{--}=5Fe^{++}+2S,$$

which shows that iron is reduced by gaining a total of four electrons per five atoms involved, while two atoms of sulfur are oxidized by losing a total of four electrons. The iron (Fe^{+++}) thus acts as an oxidizing agent, which would seem to be contrary to the rule laid down; but S^{--} is already in the reduced state, whereas Fe^{+++} is in a highly oxidized state; therefore the ferric iron can act in this case as an oxidizing agent. However, it should be noted that Fe^{++} is a fairly good reducing agent, while S itself is a weak oxidizing agent; therefore this reaction should be carried out in a reducing medium; or, in other words, air agitation should not be employed in leaching chalcopyrite with ferric sulfate.

The Periodic Table

As stated before, this arrangement shows the properties of the elements, in their *maximum valence,* as a periodic function of their relative masses. For our present purposes, the most important facts to be noted are, first, that the basic properties decrease from left to right across the table,—that is, the tendency to lose electrons decreases steadily from groups I to VII. Hence, elements far apart in the table tend to form the most stable, and the simplest, compounds. Second, the basic qualities in any one group, or family, tend to increase with atomic weight. Thus, in group II, barium is a stronger base than is strontium; and strontium, in turn, is a stronger base than is calcium. Again, in the halogen group, the acidic properties decline steadily from fluorine to iodine. Third, compounds formed between elements close together, and especially in the intermediate groups, are apt to be unstable and complex.

The arrangement of the elements according to their probable atomic structure, as shown in the table on page 14, serves to bring out the periodic variation of physical properties, as well as the reason for the variation in chemical properties.

LEACHING METHODS AND APPARATUS

Depending upon the grade and type of ore, leaching operations are carried out either in batches, or by some continuous method. Sometimes both are used in treating the same ore. Thus, coarse, low-grade ores are usually leached in batches, while concentrates, and slimes, are commonly treated in continuous agitation systems.

The oldest method of leaching is probably the Heap Leach; certainly this method is cheap, relatively easy, and requires very little investment in plant or equipment. Heap Leaching of copper ores has been carried on at Rio Tinto, Spain, for centuries; more recently it has been applied to low-grade ores at Bisbee, Arizona[13]. The essential mechanism here is the oxidation of sulfides to sulfates, usually by the action of oxygen-carrying solutions and ferric salts, and the dissolution of these, and other water-soluble compounds, by very dilute solutions percolating slowly downward thru the heap. Acid mine waters, mixed

[34]—G. N. Lewis, Valence and the Structure of Atoms and Molecules, N. Y., 1923.

[35]—Lewis & Randall, op. cit., p. 433.

Data on Properties and Structure of the Elements

(From International Critical Tables)

Remarks	Name	Atomic No.	Atomic Weight	Melting Point °C	Boiling Point °C	Density (A = Air) gm./cm 3	No. and Arrangement of Orbital Electrons K	L	M	N	O	P	Q	Valence
1 Element 1 Orbit	H	1	1.0077	− 259.14	− 252.7	0.0695A	1							1
8 ELEMENTS 2-orbit series.	He	2	4.00	< 272.2	− 268.9	0.137A	2	0						0
	Li	3	6.939	186.	>1200.	0.53	2	1						1
	Be	4	9.02	1350.	1500.	1.8	2	2						2
	B	5	10.82	2300. ?	2550.	2. cr.	2	3						3
	C	6	12.000	(3500.)	4200.	3.51 di.	2	4						4
	N	7	14.008	− 203.86	− 195.8	0.967A	2	5						3 or 5
	O	8	16.000	− 218.4	− 183.0	1.1053A	2	6						2
	F	9	19.00	− 223.	− 187.	1.31A	2	7						1.
8 ELEMENTS 3-orbit series.	Ne	10	20.2	− 248.67	− 245.9	0.674A	2	8	0					0
	Na	11	22.997	97.5	880.	0.97	2	8	1					1
	Mg	12	24.32	651.	1120.	1.74	2	8	2					2
	Al	13	26.96	660.0	1800.	2.702	2	8	3					3
	Si	14	28.06	1420.	2600.	2.4	2	8	4					4
	P	15	31.024	44.1	280.00	1.82 yel	2	8	5					3 or 5
	S	16	32.065	112.8	444.6	2.07 rh.	2	8	6					2, 4, 6
	Cl	17	35.458	− 101.6	− 34.6	2.49A	2	8	7					1, 3, 5, 7
18 ELEMENTS 4-orbit series; valence electrons in two shells.	A	18	39.91	− 189.2	− 185.7	1.38A	2	8	8	0				0
	K	19	39.095	62.3	760.	0.86	2	8	8	1				1
	Ca	20	40.07	810.	1170.	1.55	2	8	8	2				2
	Sc	21	45.10	1200.	(2400.)	(2.5)	2	8	9	2				3
	Ti	22	47.9	1800.	>3000.	4.5	2	8	10	2				3 or 4
	V	23	50.96	1710.	(3000.)	5.96	2	8	11	2				3 or 5
	Cr	24	52.01	1615.	2200.	7.1	2	8	12	2				2, 3, 6
	Mn	25	54.93	1260.	1900.	7.2	2	8	13	2				2, 4, 6, 7
	Fe	26	55.84	1535.	3000.	7.86	2	8	14	2				2 or 3
	Co	27	58.97	1480.	2900.	8.9	2	8	15	2				2 or 3
	Ni	28	58.69	1452.	2900.	8.90	2	8	16	2				2 or 3
	Cu	29	63.57	1083.	2310.	8.92	2	8	18	1				1 or 2
	Zn	30	65.38	419.43	907.	7.140	2	8	18	2				2
	Ga	31	69.72	29.75	>1600.	5.91	2	8	18	3				2 or 3
	Ge	32	72.38	958.5	2700.	5.36	2	8	18	4				4
	As	33	74.96	814. s	615. s	5.7	2	8	18	5				3 or 5
	Se	34	79.20	220.	688.	4.80 cr	2	8	18	6				2, 4, 6
	Br	35	79.916	− 7.2	61.1	3.119	2	8	18	7				3 or 5
18 ELEMENTS. 5-orbit series; valence electrons in two shells.	Kr	36	82.9	− 169.	− 151.8	2.818A	2	8	18	8	0			0
	Rb	37	85.44	38.5	700.	1.53	2	8	18	8	1			1
	Sr	38	87.62	800.	1150.	2.6	2	8	18	8	2			2
	Yt	39	89.0	1490.	(2500.)	5.51	2	8	18	9	2			3
	Zr	40	91.0	1700.	(2900.)	6.4	2	8	18	10	2			4
	Cb	41	93.1	1950.	>3300.	8.4	2	8	18	11	2			3 or 5
	Mo	42	96.0	2620.	3700.	10.2	2	8	18	12	2			3, 4, 6
	Ma	43	—	(2300.)	—	—	2	8	18	13	2			— —
	Ru	44	101.7	2450.	>2700.	12.2	2	8	18	14	2			3, 4, 6, 8
	Rh	45	102.91	1956.	2500. ?	12.5	2	8	18	15	2			3
	Pd	46	106.7	1555.	2200.	12.0	2	8	18	16	2			2 or 4
	Ag	47	107.880	960.5	1955.	10.50	2	8	18	18	1			1
	Cd	48	112.41	320.9	767.	8.6	2	8	18	18	2			2
	In	49	114.8	155.	>1450.	7.3	2	8	18	18	3			3
	Sn	50	118.70	231.85	2260.	5.750 gr	2	8	18	18	4			2 or 4
	Sb	51	121.77	630.5	1380.	6.684	2	8	18	18	5			3 or 5
	Te	52	127.5	452.	1390.	6.24	2	8	18	18	6			4 or 6
	I	53	126.932	113.5	184.35	4.93	2	8	18	18	7			1, 3, 5, 7
32 ELEMENTS. 6-orbit series; valence electrons in three shells.	Xe	54	130.2	− 140.	− 109.1	4.422A	2	8	18	18	8	0		0
	Cs	55	132.81	26.	670.	1.90	2	8	18	18	8	1		1
	Ba	56	137.37	850.	1140.	3.5	2	8	18	18	8	2		2
	La	57	138.91	826.	1800.	6.15	2	8	18	18	9	2		3
	Ce	58	140.25	640.	1400.	6.90	2	8	18	19	9	2		3 or 4
	Pr*	59	140.92				2	8	18	20	9	2		
	Nd	60	144.27				2	8	18	21	9	2		
	—	61	—				2	8	18	22	9	2		
	Sm (So)	62	150.43				2	8	18	23	9	2		
	Eu	63	152.0				2	8	18	24	9	2		
	Gd	64	157.26				2	8	18	25	9	2		
	Tb	65	159.2				2	8	18	26	9	2		
	Dy	66	162.52				2	8	18	27	9	2		
	Ho	67	163.4				2	8	18	28	9	2		
	Er	68	167.7				2	8	18	29	9	2		
	Tm	69	169.4				2	8	18	30	9	2		
	Yb	70	173.6				2	8	18	31	9	2		
	Lu	71	175.0				2	8	18	32	9	2		
	Hf	72	178.6				2	8	18	32	10	2		
	Ta	73	181.5	2850.	>4100.	16.6	2	8	18	32	11	2		5
	W	74	184.0	3370.	5900.	19.3	2	8	18	32	12	2		2, 4, 5, 6
	Re	75	—	(3000.)	—	—	2	8	18	32	13	2		—
	Os	76	190.8	2700.	>5300.	22.48	2	8	18	32	14	2		2, 3, 4, 8
	Ir	77	193.1	2350.	>4800.	22.4	2	8	18	32	15	2		3 or 4
	Pt	78	195.23	1755.	4300.	21.45	2	8	18	32	16	2		2 or 4
	Au	79	197.2	1063.0	2600.	19.3	2	8	18	32	18	1		1 or 3
	Hg	80	200.61	− 38.87	356.9	13.546	2	8	18	32	18	2		1 or 2
	Tl	81	204.4	303.5	1280.	11.85	2	8	18	32	18	3		1 or 3
	Pb	82	207.20	327.5	1620.	11.34	2	8	18	32	18	4		2 or 4
	Bi	83	209.00	271.	1450.	9.80	2	8	18	32	18	5		3 or 5
	Po	84	(210.)	(1800.)	—	—	2	8	18	32	18	6		—
	—	85	—	(470.)	(520.)	—	2	8	18	32	18	7		—
7 ELEMENTSxx Radio-active. 7-orbit series	Rn	86	222.	− 71.	− 61.8	(4.7)	2	8	18	32	18	8	0	0
	—	87	—	(23.)	(620.)	—	2	8	18	32	18	8	1	1
	Ra	88	225.95	(960.)	1140.	(5.?)	2	8	18	32	18	8	2	2
	Ac	89	—	(1800.)	—	—	2	8	18	32	18	9	2	—
	Th	90	232.15	1845.	>3000.	11.2	2	8	18	32	18	10	2	4
	Ux (Pa)	91	(234.)	?	(6200.)	?	2	8	18	32	18	11	2	?
	U	92	238.17	<1850.	?	18.7	2	8	18	32	18	12	2	4 or 6
	—	118	— —	— —	— —	— —	2	8	18	32	32	18	8	— —

*The so-called rare-earths are included only to show the progression in electron arrangement; hence data on M. P., B. P., Density, etc., are not shown for elements 59 to 72, inclusive.

xx Theoretically, this series should contain 32 elements, the arrangement of electrons in the three outer shells being exactly analogous to that of the preceding series of 32.

with cementation tank solution, and a large excess of neutral water, constitute the solvent. The process is slow, of necessity; but can be shortened by providing air channels, or chimneys, thru the heap, and by applying the solvent in a spray over the heap.

Stope Leaching is a variation of this, used in extracting residual values from old workings. The solvent is simply pumped into old stopes containing broken ore of a grade too low to permit of hoisting and heaping; then the solution is pumped out again, and the copper values recovered by cementation (replacement by scrap iron, etc.).

The great bulk of batch leaching, however, is carried out in large vats, or tanks. The coarsely broken ore is charged and discharged by means of grab buckets, or other suitable machine methods. The tanks have a false bottom, covered with some sort of filtering material, and the solvent solution is applied either on top, or from the bottom. The necessary relative motion is secured by the percolation of the solution thru the solid bed. Upward percolation is usually better than downward, in that when solutions are forced upward thru the ore, there is little chance for channeling, or the formation of air pockets,—thus insuring a more uniform action throughout the bed.

In modern practice[35] the vats are usually made of concrete, brick, or wood, lined with some acid-proof material, such as mastic, tar, or lead. The tendency is to build for large ore capacity per tank,—say, 5,000 to 10,000 tons per charge. The solutions are circulated by means of air-lifts, centrifugal pumps, etc.[36].

For best results the ore should be broken so that the maximum surface is exposed; the limit of crushing is determined by extraction, time of leaching, and other technical factors balanced against costs. In general, a uniform grain size is more desirable than a small average grain size. In fact, in one large plant it has been found very economical to separate the slimes by classifiers and give them separate treatment in slime agitators[37].

The counter-current principle is applied as regards movement of solutions from one tank to the next. (Fig. 5). Thus, the tank containing fresh ore is treated with solution which contains the minimum amount of solvent reactant while the most nearly exhausted ore, receives solution which contains the maximum strength of reactive solvent. For example, at Inspiration, Arizona[38], "The thirteen concrete, lead-lined leaching tanks are each 175 ft. long, 67.5 ft. wide, and 18 ft. deep, and have a capacity of 9,000 dry tons of ore per tank. They are lined with 7-lb. chemical lead . . . In charging, the ore is distributed equally over the entire tank . . . practically no rolling or segregation of the material in the tank takes place. The ore, after bedding, is first covered with a solution strong enough to avoid neutrality at any point within the charge . . . Percolation of solutions is upward. Each tank is provided with a vertical screw type lead pump which receives the overflow solution from the preceding tank and pumps it underneath the filter-bottom and up through the ore. The solution overflows into a launder and goes to the suction of the pump serving the next tank, which permits the tanks under acid treatment to be in series. The circulation on each tank is approximately 1,500 g.p.m.

"The complete cycle is thirteen days, as one tank is excavated and one filled each day. Eight tanks are under

[35]—Hofman & Hayward, Metallurgy of Copper, Ch. VIII.
[36]—Hofman, General Metallurgy, p. 687, et seq.
[37]—Slime Treatment and Electrolytic Precipitation at Inspiration, Aldrich & Scott, E. & M. J. 128, 17, 652 (1929).
[38]—Leaching Mixed Oxide and Sulphide Copper at Inspiration, Aldrich & Scott, E. & M. J. 128, 16, 612 (1929).

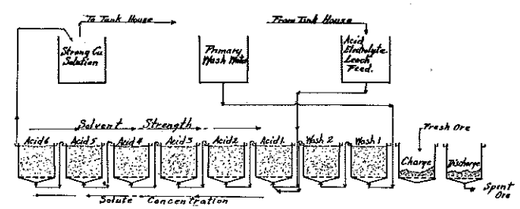


FIGURE 5

Schematic Diagram of Sand Percolation Leach System.

acid contact at all times, three are being washed, one tank is being filled, and one being excavated. The strong acid solution from the tank house, in which sulphuric acid and ferric sulphate have been regenerated, and to which the required amount of new acid has been added, is delivered to the oldest ore under acid contact. This solution travels from tank to tank, constantly being reduced in solvent strength, and increased in copper content, until it emerges from the newest ore, after which it flows back to the tank-house."

In downward percolation it is better to apply the solution in batches, allowing each batch to drain before applying the next batch, since in this way there is effected a displacement of the relatively lean solution absorbed in and adhering to the ore by the following richer solution. However, batch application is not as important in leaching as it is in washing.

As stated above, slimes and other relatively fine-grained materials, such as roasted concentrates, are usually leached by some sort of agitation of the entire pulp. The reasons for such treatment are, first, that percolation through slimes is slow; and, second, that such materials are usually higher in grade than are those handled in batch leaching, less solution volume is required, and a high value of plant capacity becomes an economic necessity.

In cases where the solvent is non-corrosive toward the material of the equipment, a large portion of the desired dissolution can be obtained by carrying out the final grinding operations in the solvent itself. Most fine grinding (from, say, 4-mesh to 100-mesh or finer) is usually done in wet circuit, since this allows of a lower power consumption, low dust loss, and close classification. Hence, it is merely a matter of killing two birds with one stone to add the solvent direct to the last grinding stage. This is common practice in the cyanidation of gold and silver ores.

Slime agitators may be listed generally as paddle (with and without baffles), propeller, and air (with or without air-lift). Paddle agitators simply rotate the entire pulp, and there is little relative motion of solids and liquid. The addition of baffles brings about swirls which materially aid in mixing of the pulp. Propeller agitators have a somewhat better characteristic than paddles in that settling is largely prevented; but still there is too little relative motion of the pulp constituents, and power costs are relatively high. Air-lift agitation is much more efficient than either of the foregoing methods; two types may be distinguished here. The Dorr Agitator (Fig. 6) consists of a cylindrical tank containing a central vertical shaft. At the base of this shaft are rabble arms, fitted with rakes, which move the settled particles toward the center. The shaft is hollow, with holes near the bottom and top, and supplied with a compressed air jet at the base. Thus, as the arms revolve slowly, forcing the heavy, settled pulp toward the center of the bottom, the air lift action in the shaft forces this heavy

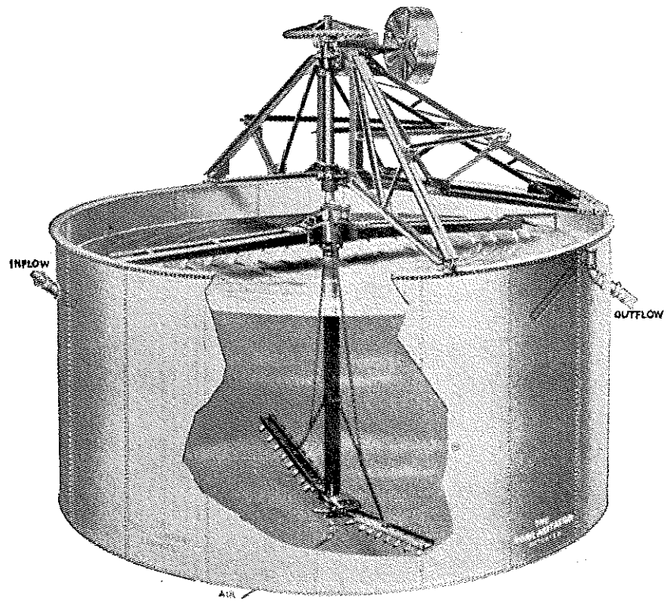


FIGURE 6
The Dorr Agitator

pulp to the top, where it is distributed to the supernatent solvent again by launders. This provides for nearly perfect relative motion of the solids and liquids. The power consumption is about one-eighth that required by the same size of paddle agitator, and the "short-circuiting effect" is almost completely eliminated. The Pachuca tank (Fig. 7) is another form of air-lift agitator in which there are no moving parts; the bottom of the tank is coned, so that the settled particles may slide down toward the bottom of the central air-lift column. The main difficulty encountered in this type of agitator is the building up of solids along the side walls near the bottom; this leads to channeling, and lack of uniform leaching; sudden slips of this caked material may also cause clogging of the air-lift.

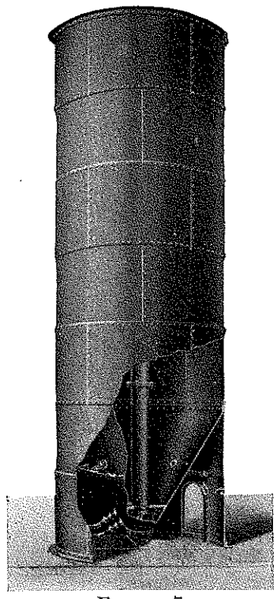


FIGURE 7
Air Agitation Tanks

Steam may be substituted for air in either the Dorr or Pachuca types when heating action is also required; in some cases a steam-air injector, such as is used on gas producers, may be used. When the oxidizing effect of air is harmful, however, it is usually best to resort to purely mechanical agitation.

Continuous agitation implies an equal and uniform rate of feed and discharge of materials. This, in turn, requires that we know the amount of material to be treated in any given period of time, the time of contact required to bring about the desired extraction, and the solid/liquid ratio of the pulp. In practice it is impossible to provide for an absolutely uniform time of contact of all particles with the solvent: some particles will be "short-circuited" and discharged almost immediately; others will remain in the agitator a very long time; but we can compute, from the test data mentioned above, the *average* length of time required for a given tank or unit. The problem, then, is simply one of providing sufficient volume and time of retention to effect the required dissolution.

Due to the "short-circuiting effect", it is good practice to use a number of relatively small tanks, set in cascade, or series feed, rather than a few large tanks. The pulp then flows from the head to the foot of each series, having a definite average time of retention in each tank; but for the cascade as whole the motion of solids and liquids is concurrent. In order, then, to obtain the counter-current effect, and thus increase the reaction velocity for the extraction as a whole, it is customary to split the leach into stages in such a way that at the end of each stage the solids and liquids are separated,—to a certain extent,—the solids moving to strong solution again, and the liquids moving to rich solids.

For example, in the extraction of zinc from roasted concentrates by dilute H_2SO_4, the leach is split into two parts, the "acid leach" and the "neutral leach". Each of these parts may consist of several agitators, set in cascade, feeding into one or more thickeners. (See Fig. 8) The fresh calcine is first fed, either in whole or in part, into the "neutral leach" agitators together with solution which has almost been neutralized previously. After passing through these agitators, the pulp goes to thickeners; the neutral overflow passes to the purification and electrolytic system, where the zinc is precipitated and acid regenerated;

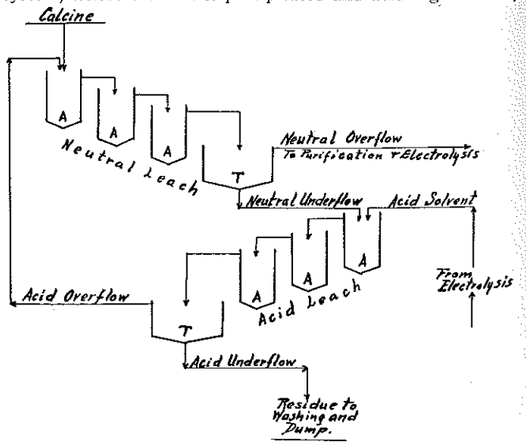
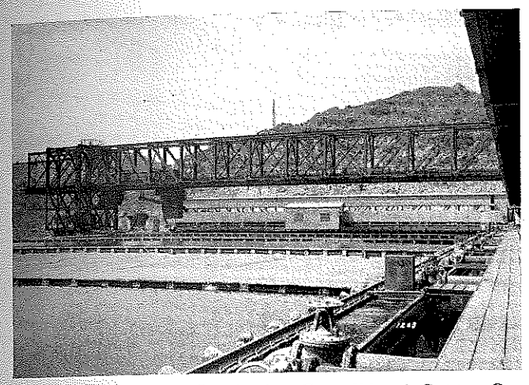


FIGURE 8
Two-Stage Zinc Leach System (Low Acid Process)

the neutral underflow goes to the "acid leach" agitators, where it meets the strong acid solution returning from the electrolytic system. At the end of the acid cascade, the pulp again is fed to thickeners; the overflow goes to the neutral leach agitators, and the underflow, which contains the spent solids, goes to the washing system,—the wash water being added to the neutral leach, and the washed, filtered solids going to the dump, or to further treatment for other values.



Leaching Tanks at Inspiration Consolidated Copper Co. See Figure 5

Thus the movement of the solids and liquids in a given stage, or set of agitators, is concurrent; but for the leaching system as a whole, the movement is counter-current. Figure 9 shows the arrangement of agitators and thickeners for a four-stage continuous counter-current leach.

One further fact remains to be noted: in our development of the equation for reaction velocity, it was assumed that the solute *in the solid phase* had no influence on the rate or progress of the reaction. This is not strictly true: especially in the case of rich concentrates, the presence of a large amount of undissolved, reactive material in the solid phase does exert a definite influence, not only on the rate of the reaction, but on its course as well. For instance, in the zinc leach illustrated above, the addition of fresh calcine to nearly neutralized solvent serves a double purpose: first, to bring about complete neutralization as quickly as possible; and, second, to build up the alkalinity of the solution (by saturation with $Zn(OH)_2$) to such a point that ferric iron will precipitate as $Fe(OH)_3$. Thus, at 18°C, the solubility product of $Zn(OH)_2$ is given as 1.8×10^{-14}, while that for $Fe(OH)_3$ is much smaller, 1.1×10^{-36}; and the value for $Fe(OH)_2$ is slightly higher

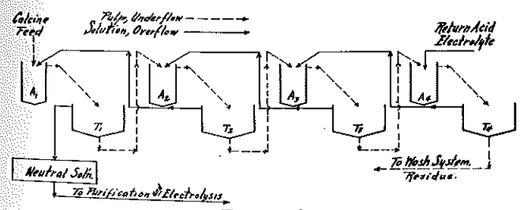


FIGURE 9
Schematic Diagram of Continuous Slime Counter-Current Leach System.

than that for $Zn(OH)_2$, 1.64×10^{-14}. In other words, zinc hydroxide can precipitate ferric hydroxide, but not ferrous hydroxide. And incidentally this illustrates the value of poking about in the realm of elementary inorganic chemistry when developing a process.

Mercury, Mineral of Many Uses

Approximately one thousand uses are claimed for mercury. In many lines, satisfactory substitutes for the metal are employed; but in other lines there is a constant ebb and flow as consumers experiment with first one substitute and then another, only to return to mercury. Neon lights already consume about one thousand flasks of mercury each year, states Paul M. Tyler, in a report recently issued by the Bureau of Mines. Other new uses are the making of soda to be employed in the manufacture of artificial silk, certain processes connected with petroleum refining the manufacture of automatic switches for iceless refrigerators and other electrical devices, radio tubes, storage batteries, and a fertilizer compound for grass on golf courses. The Emmet mercury boiler is another potential factor in future demands. Mercury heated in one boiler is used first like steam to drive a turbine and is thence exhausted into a second boiler which acts as a condenser for the mercury and as a source of steam to drive another turbine.

Although there is no destructive consumption of mercury in a mercury power plant each new installation will absorb a considerable quantity of the metal, as between 6 and 8 pounds are required per boiler horse-power installed. It is proposed to use mercury as a heat carrier in a somewhat similar way for cracking gasoline.

Pharmaceuticals, chemical manufacturing processes, neon and mercury lights, pigments and cosmetics, and the electrical industry are steady consumers. Mercury-containing disinfectants for seed treatment are gradually being replaced by cheaper substitutes.

Many attempts have been made to find substitutes for the mercury fulminate used in blasting caps and ammunition. Manufacturers have long threatened to use such substitutes at times of high mercury prices, but it seems significant that the use of the metal for explosive caps has not decreased during times of high prices. Bridge, dam, subway, mine and all other work requiring explosives will be continued and will probably continue to take toll of mercury.

One surprising factor disclosed by the survey is the relatively large proportion of the mercury output used for scientific and technical instruments. The consumption of mercury for amalgamation processes of recovering gold, which is now declining and will soon be negligable, was formerly large, but the decline in this use has been more than compensated by the use of mercury for scientific and technical instruments. Modern industry has turned more and more to scientific and quasi-automatic-control methods in its processes. As mercury is a liquid metal at ordinary temperatures, it has in these processes a unique field of usefulness. To have faith in the future of modern industry is to have confidence in the future of mercury.

Two English cockney broom vendors met on a London street and started at once to talk business.

"'Ang it all," said one. "I don't see 'ow you can sell these 'ere bloomin' brooms for a shillin'. I steals the brush, an' I steals the wire, an' I steals the 'andles an' I can't sell 'em for a shillin' and make any money on 'em."

And the other replied: "Why, I steals 'em ready made."

Chemistry in Relation to Industry and Its Development

coal and its by-products

By SUSANA PFEIFFER

MR. MULVIHILL has stated that more than one thousand items can be made from the by-products of coal and that the value of all marketable products of bituminous coal would run over $2,000 per ton.[1]

In 1926, two counties in southern Illinois, Franklin and Williamson, together mined 23,890,878 tons of coal. This coal sold for $2.40 a ton at the mine. A large percent of the possible profit on these millions of tons of coal was lost because the coal operators did not make full use of the knowledge of expert chemists.

Notwithstanding the fact that the coal fields of the United States are extensive, the coal supply is not inexhaustible. So much coal is being used and wasted now that, it has been calculated, the supply will be exhausted in ninety years[2]; supposing no changes in per cent or rate of extraction are made. This short period of ninety years could be extended to a few hundreds of years if man's knowledge of chemistry should be properly applied. This can be done by a chemical modification of the volatile matter either in amount or form, so that a smokeless fuel will result and possibly also a fuel of a higher rate of efficiency in combustion. The best known form that fulfills these conditions is coke.

SUSANA PFEIFFER

Like father, like daughter. This is a paper prepared in elementary chemistry at Herrin High School, Illinois. Miss Pfeiffer is the daughter of G. N. Pfeiffer who was graduated from the Colorado School of Mines in 1905. He is a life member of the Alumni Association.

Bituminous coal, as mined in Southern Illinois, is a rather hard, black, dense hydro-carbon, in which the volatile matter and fixed carbon are nearly equal. The average analysis of coal of Williamson and Franklin Counties is almost identical. The average analysis of Franklin County coal, moisture free, as given by State authorities[3], is as follows: volatile matter, 36.75 per cent; fixed carbon, 53.57 per cent; ash, 9.61 per cent; sulphur, 1.54 per cent; carbon dioxide, .41 per cent; B. T. U., 13023, and specific gravity of about 1.3.

In the making of coke out of bituminous coal many other by-products result. Although an extensive market does not exist for some of these by-products now, such a market could be built up. The low-temperature of distillation of coal is bringing these results about.

BY-PRODUCTS OF BITUMINOUS COAL

The chief importance of low-temperature distillation to the coal industry is expected to be in the broadening of the field of uses for coal. The expansion of low-temperature distillation will encourage the production of a high grade, smokeless fuel, gas for domestic use, tar, fuel oil and motor spirits.

Iu 1924 in the United States, 49 million tons of coal carbonized in by-product ovens gave the following average results per ton: 11,030 cubic feet gas, 8.6 gallons tar, 22.2 pounds ammonium sulphate, and 2.9 gallons crude light oil.[4]

The tars obtained from the coal were once looked upon as troublesome waste products rather than products of value. Tars are now destined to be the most important products of low-temperature carbonization, since, on account of their similarity to petroleum products, they can be used largely as substitutes for petroleum oils in the industry. The refined light oils from the tar may be sold as motor spirit, for which there are good prospects of an ever increasing demand. In distilling the crude tar the following products may be found: benzol and its homologues, used in the color industry and as paint and fat solvents; the carbolic oils, much in demand for disinfectants of various kinds; and the creosote and anthracene oils. The chief use of creosote is to preserve timber. Although not generally used yet, it is used in mines to preserve the timber which supports the roofs of the haulage ways and in the ties under the track. The pitch residue of coal tar is used in roofing, paving, and road building. Coal tar is used for the dipping of cast iron pipes.

To show some of the varied uses of coal tar it can be said that if a person goes to a confectionery for a soda in all probability his or her soda will be flavored with something extracted from the coal tar. Then, if this makes the person sick and he goes to a doctor, the doctor will probably give him a medicine made from the same coal tars.

Gas coals may be defined as high volatile coking coals suitable for the manufacture of city gas. More than one-half of coal gas used in the cities comes from by-product ovens. In 1924, more than sixty-five billion cubic feet of coke-oven gas were distributed through the city mains. When carbonized in by-product ovens, gas coals may be used alone, or with an admixture of low-volatile coal to improved coke quality.

More ammonia is obtained from Illinois coals than eastern coals. By using phosphoric acid plus the ammonium liquid, produced from the by-product ovens, the phosphoric acid may be used in the manufacture of fertilizer. Phosphoric acid is the correct thing to use to fix ammonia for fertilizer, not sulfuric acid.

Coke, the carbonaceous product remaining after the coal has been subjected to destructive distillation, is chiefly composed of carbon, but contains small percentages of moisture, ash, sulphur, phosphorus, and such of the volatile matter as the temperature employed failed to drive out.

1—Mining and Metallurgy, Nov. 1928, page 515.
2—Illinois Eng. Experiment Station Bulletin No. 30.
3—Illinois Geological Survey Bulletin No. 27.
4—Trans. of Amer. Inst. of M. & M. Eng., Vol. 74—H. J. Rose.

A good grade of coke is a cellular, steel gray, hard mass of material. Coke, commonly, is sold under the following names: furnace coke, domestic coke, foundry coke, and breeze.

Furnace coke is the fuel employed in modern blast furnace practice for the reduction of iron from the ore and for smelting the ores containing precious metals. A coke to meet this requirement, successfully, must have certain chemical and physical qualities. Chemically, it must be low in ash, sulphur, and phosphorus; and it must be high in fixed carbon, which is the heat yielding constituent of coke. Physically, it must be uniformly strong in order that it may withstand the weight of the furnace charge.

Foundry coke is used in cupolas, and since the burden is more concentrated, larger and tougher pieces of coke are required. This coke should have a sinewy structure, be dense, firm, with a metallic ring, and resistant to pressure. This coke is made in a beehive oven.

The introduction of coke for domestic use dates back to the close of the eighteenth century, gas house coke being used in grates in England in a small way for a number of years. It failed to arouse the enthusiasm of the householder because of the difficulty in ignition, the full, cheerless fire, and the fumes given off in burning. These troubles were brought about by lack of drafts but, as they have been remedied, coke can be put into domestic use. The best domestic coke is that from the by-product ovens.

Coke breeze is the small particles of coke which break off in the course of its handling. In the past, practically all the coke breeze has been wasted. It is now used in firing furnaces. Steam boilers of over 2000 H. P. are being successfully operated, using coke breeze as fuel.

Legend has it that the first coke from Southern Illinois coal was discovered in Benton Harbor. A large coal pile burned. When the debris was removed a keg was found and inside the keg was coke. Apparently someone had filled the keg with coal and had forgotten about it. Nobody knew just what happened but the coal inside the keg had become coke. If Illinois coal could be coked accidentally it surely could be coked intentionally. The work began.

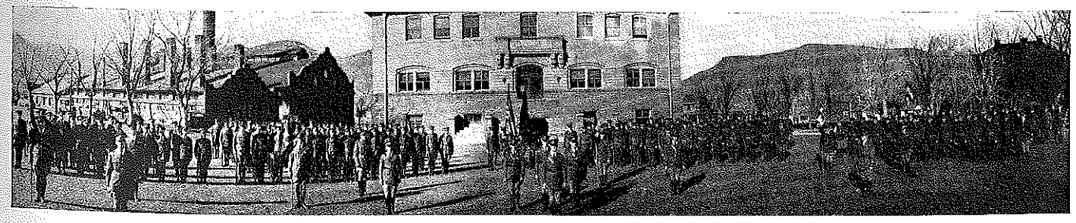
One of Europe's foremost scientific wizards of that day, Doctor Moss, was sent for. Doctor Moss started to install his idea but his scheme collapsed because of shortage of funds. Appeals were made to the late steel king, Judge Gary. Gary became interested because coke is the life of the steel industry. Experiments, which involved much money, were carried on. Success was very near when the Great War came on. The work was dropped temporarily. Then, the Hanna family became interested and ordered twenty-four ovens to be built near Dover, Ohio. These ovens today cost about $75,000 a unit. But with the Great War on and times full of trouble, the project was dropped.

It took 21 years to prove that Illinois coals could be coked. Millions of dollars were spent in the task.

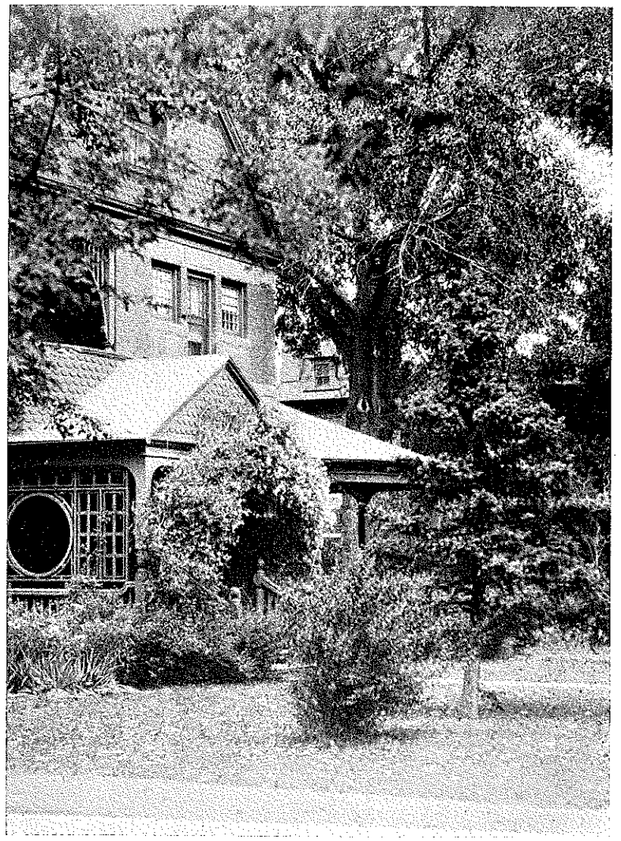
Tobacco Smoke and Lies

You remember that night at the good old "Unknown"
With the snow drifted deep at the door?
On the rimrock outside we could hear the wolf's tone
As we dumped the pine knots on the floor.
There was Charlie from down the Belle Fourche River
brakes,
And the cook of the old Lazy V's,
And big Irish Van, who had cleaned up the stakes
In the lumberjack fight at McGee's.
And Tracy who knew every canyon and ridge
From the "Terror" to Keenan's Gold Dime
Every swale and divide from the old Cheyenne bridge
To the furthermost gulch in the "Lime".
And old Gerrish himself, who had staked out his claim
And had worked on his "Lucky Boy" mine,
With a courage and faith that was always the same,
Since the summer of "seventy-nine".
We spread out our blankets, threw on some fresh wood,
Filled our pipes from the old Velvet can,
Tipped back our chairs just as far as we could,
And the meeting was opened by Van.
He told of a bear, stumbled onto one day
Way back in his wild younger years,
Too sudden to get his big Colt into play
So he bulldogged the brute by the ears.
Then Charley chipped in of that terrible snow
In the fall of eighteen ninety-four,
When the mercury fell down to forty below
And a bull elk broke in the back door.
"I was minin' that time up on Little Crow Peak",
Tracy drawled, as he turned up the lamp.
"I crawled in my gold pan, too frozen to speak,
And slid seven mile down into camp".
"You know of Paul Bunyan, the first lumber-jack?",
Gerrish asked with a gleam in his eye.
"He contracted with Noah, some few ages back
For to lay in his lumber supply.
"Two small nigger lads with bacon rind shoes
Kep' the griddles greased skating across,
Missus Bunyan distilled forty stock tanks of booze
Just to keep the boys right with the boss".
"Now it seems that friend Paul had a famous blue ox,
A critter of tol'able size,
No one was quite able to reach to his hocks
He was forty-one feet 'tween the eyes".
"What's that you say? I'm a gettin' it wrong?
No, we don't never lie in this shack!
Tracy, pick up that fiddle and give us a song,
While I mend up that hole in your pack".
You remember that night at the dear old "Unknown",
And the outlandish tales that were told?
I can live them again as we sit here alone,
Those rollicking sessions of old.

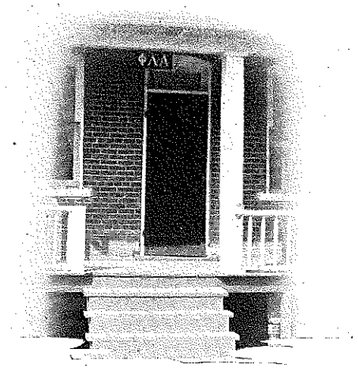
—*C. W. Hughes, Rapid City, S. Dak.*



The R. O. T. C. is one of the most popular activities at the Colorado School of Mines.

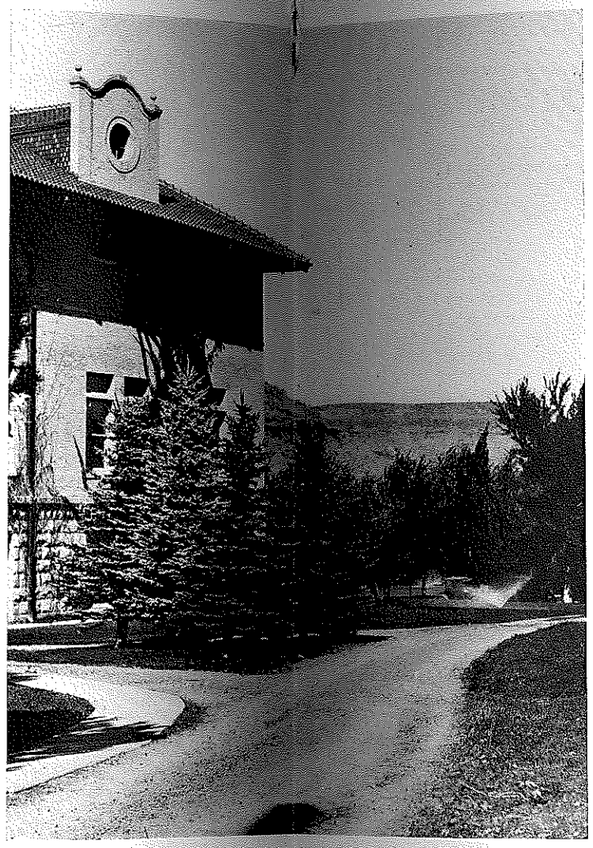


The Dean's Residence

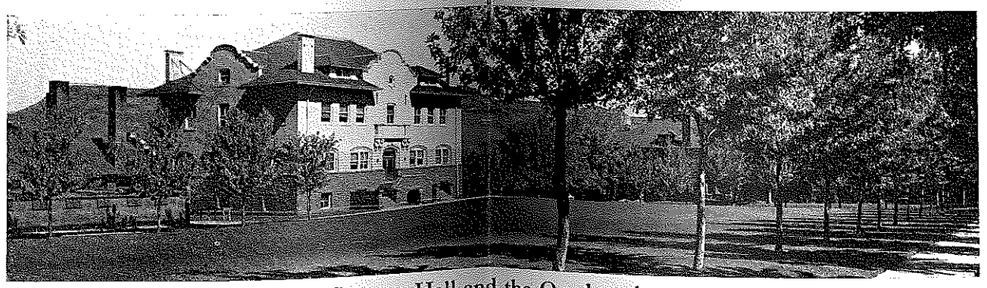


ΦΛΑ Entrance

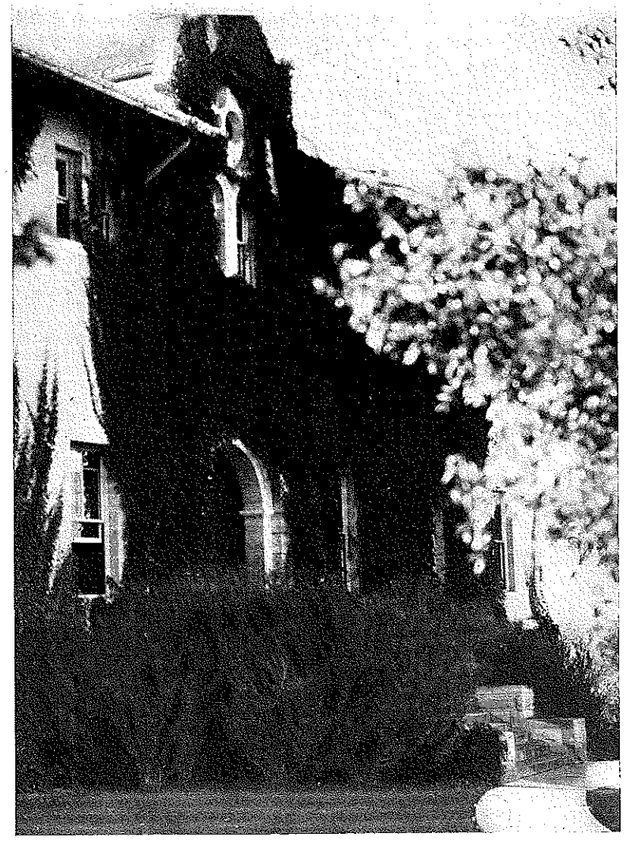
Looking at the Campus from A Different Angle



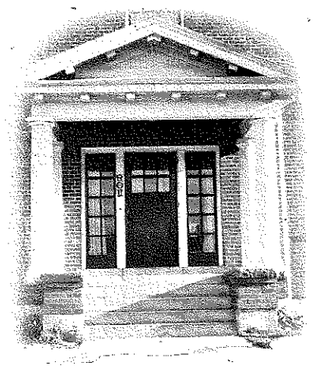
Guggenheim Hall and South Lane



Stratton Hall and the Quadrangle



Entrance to Gymnasium

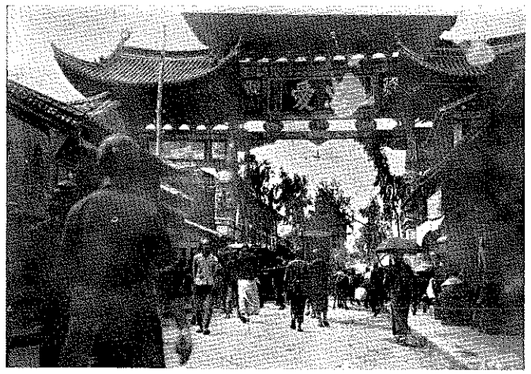


ΣΘΠ Entrance

A Trip to A Deep Mine in China

By MARSHALL D. DRAPER, '97

SOME years ago, in 1920 to be exact, Dr. H. Foster Bain and myself were designated by the State government of Yunnan, China, to examine various of the government controlled mines of the province and to that end we proceeded to Gunnanfu, the capital of the Province. After a considerable wait at the capital, while several nearby bandit disturbances were being settled, we were able to depart with a military escort, to prevent our being kidnapped en route and held for ransom. This is a rather unpleasant occurrence to say the least, from the tales of various Europeans who have undergone that experience as the bandit soldiers invariably retreat to some mountain fastness from which it is difficult for the government troops to dislodge them and the unfortunate kidnapee is meanwhile figuratively dragged around by the nape of the neck by the retreating bandits.



No untoward incident happened on this particular trip however, and we made our way without other than the usual discomforts attending a long trip muleback. Ten days North of Yunnan, the government has established at the town of Tung Chuan a base of operations for various of its copper mines, located some distance to the Northwest. We were received with the usual punctilious courtesy of the Chinese officials and after a day or two there, proceeded on our way to various copper mining centers and returning some weeks later, then set out for a lead-silver district to the East. This place, called Kung San was reached in 1.5 days travel and the distance East from Tung Chuan is about 50 miles. I quote from my notes as follows:

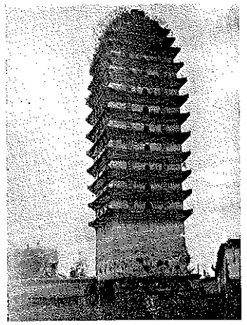
MONDAY SEPT. 6. Lv. Tung Chuan for Kung San at 8:20 A. M. Flat country and cart road over which many carts are now coming laden with coal. Many carrier coolies are also met carrying coal. No matter how cheap labor is, it would seem that good roads would allow the coolie labor to be devoted to better purposes. Good roads are one of the most important of China's needs. After 1.5 hours at noon camp again took the road. Several carts were overtaken going N. E. with pig copper.

Arriving Ta Kiao, a small village about 1 mile from a considerable sized lake (some miles in length) at 4:30, we camped in outskirts of village for the night. Trav. time 7 hours; Distance 80 li (27 miles).

TUES. SEPT. 7. Lv. Ta Kiao 7:00 A. M. went on E. over fairly level country skirting the South edge of the lake, thence up water grade of small creek. Most of this trail has been over good cartroad a most welcome change from the bad trails, high rivers, mud waves and quicksands of the trails to Tan Dan. About 10 A. M. we encounter coal seams which have been extensively worked. They are small—perhaps 12 to 18 in. width. Shortly thereafter we pass some extensive dumps composed of slag, broken zinc retorts and cinders, and later still larger slag dumps. These are no doubt slag dumps respectively of zinc and lead smelting operations of considerable magnitude as there are many dumps increasing in number until we can see the mining camps and town of Kung San on the hill in the distance above the valley. We met Mr. Jao the Manager and were quartered in a nearby temple where the buildings partly cover an excellent clear mountain spring. Travelling time 4.5 hours. Distance 50 li. It is said to be 140 li from Tung Chuan to Kung San (about 47 miles). In the afternoon we inspected some of the surface workings where, near the town we observed a large open cut from which much ore had evidently been extracted in the past. Zinc carbonate was the principal output here and we saw several large piles stacked up awaiting treatment. It is said that 6,000 tons are now stored for the purpose. This ore would average, from appearance, 25% zinc. It was stated that recovery was 12.5% of the weight of the ore charged. I went down one of the workings in the open pit. It was the usual small timbered Chinese tunnel. The timbers were broken and the place was dangerous as active operations here had been abandoned. Zinc carbonate was in evidence at various places. At a vertical depth of 60 feet the incline branched. Direction of main zone appears to be S. 45°W., the direction of the incline being S. 35°W. This zinc zone, from which considerable production is still being made, is about 150 feet wide on the surface. The ore seems to occur indiscriminately among the weathered pinnacles of the limestone country rock and also in seams and incrustations throughout the fissured limestone. The carbonate ore is treated in native furnaces nearby, one of which had just been closed down. Ore is treated in crucibles made from nearby clay the dimensions of the crucibles being height: 18"; 6" diameter on top and 4" at bottom. Luted to the tops of these were clay ferrules or condensing chambers about 6" diam. and 6" high.

An unusual and distinctive custom at this mining camp was the rule of placing an elaborate fan shaped shelter over the first heavy sets of timber at the incline mouth. These sets were invariably of about 8 inch round timber and

dimensions of the entrance would then be some 7 feet in the clear by 4 or 5 feet wide. However, unfortunately and invariably these surface sets would funnel down so that in 10 feet there would appear the standard size sets of 3 inch timber spaced about 6 or 8 inches apart and making an inside dimension of 1 meter wide by 1.2 meters high. One must go down these cramped openings either on hands and knees or else in a crouching position so that after an hour or so, of travelling in such a continual bent position, the leg muscles in particular become very cramped. Due to this fact, the native miners invariably have very large thigh development.



WEDNESDAY, SEPT. 8. One of our smallest interpreters is Mr. Li, a graduate of Columbia, and we took him along for an examination of one of the principal mines of the camp called Hin Bao Tung. The mine Superintendent stated that the mine was divided into 8 divisions all more or less equal in length. Li and I with a Brunton compass and steel tape surveyed the first division carefully as we progressed downwards. It was said that it takes a man all day to go to the breast and return. The first 100 feet or so was sunk on the usual 30 degree slope but as the object here was merely to gain depth it had been sunk in a close spiral. After some 200 feet had been so gained the incline followed away on a more less straight course of S 25 to 30 East. The end of the first division occurred at a linear distance from the mouth of 1100 feet and the vertical angle of the slope averaged 29 degrees. Thus at this point nearly 550 feet vertically had been gained. Later three more following divisions were surveyed and the depth gained was some 2100 feet at the end of the fourth division. Lower workings were not surveyed but the same general inclination held to the furthest workings so that it is safe to say that this mine had attained a vertical depth of 4,000 feet below the shaft collar. All workings from this main incline aggregate 40 li—13 miles—it was said—in length.

Such deep mining is not uncommon in Yunnan, for in the tin district at Kotchiu, with which operations I was connected for some time, we had various workings from 2,000 to 3,000 feet in vertical depth below the incline collar. However, this Hin Bao Tung incline is the deepest working in Yunnan of which I have any knowledge and I am inclined to think that it is probably the deepest in China, for the history of Yunnan shows that it has been noted for many centuries as being a prolific producer of metals of various kinds, and the Kung San district is similarly long known as having been actively worked. The commonly encountered cavernous fault fissures in the limestone regions of Yunnan serve of course as drainage channels as well as for ventilation, and these factors together with the location on a high inland plateau traversed by deeply eroded river canyons all serve to assist the Yunnan miner in his operations at considerable depths.

The crucibles were charged nearly full of carbonate ore and were fired in banks of 75 to 100 by a coal fire built on iron grates for from 12 to 14 hours. On the inner side of each crucible was a groove to carry the zinc to the condensing chamber above. On top of each charge of ore in the crucible was placed a covering of dirt before firing the bank.

It is probable that the European methods of zinc ore treatment were originally copied from this Chinese method which itself is said to be of ancient origin. Although much zinc is produced here the Chinese officials state that the business is not at present of great importance.

In the afternoon we went to the South end of this zone where a lead mine had recently been opened. The usual incline was started, running N. 30°E. At some 200 feet down the direction changed to S 60°E. At this point, some 200 feet from surface our lights would hardly burn as no open fissures had been encountered in the limestone. (These are very common in Yunnan in most of the mine workings, being caused by faulting usually and the fault walls later eroded by meteoric waters. Mines are rarely bothered with bad air in Yunnan on this account).

It is common practice throughout Yunnan to run a crooked incline tunnel to follow the ore if possible and at such an incline—invariably 30 degrees—that the heavily laden ore carriers with one bag of ore on their back and the other on their chest, can make their way along. Stringers are being followed in various parts of this new enterprise in the hope that some of them may lead to larger bodies of ore. We were shown good specimens of cerussite and galena from this place. Nearby this tunnel was another new one. Yet, having encountered open fissures which enabled the workers to progress beyond the first few hundred feet where conditions for ventilation are always said to be worst, they had then already attained a total length it was stated of 6,000 sets of timber. As these are usually about 8 inches apart—3 inch timber being used—the depth here or rather, length of this incline was thus about 2000 feet.

Alumnus Called Beyond

J. S. DAVIS, JR., '20

Word has just reached the Alumni office of the death of J. S. Davis, Jr. on August 9, 1929. Mr. Davis was graduated from the School of Mines in 1920. He was a young man of character and with a splendid future before him. His untimely death is a loss to the engineering profession.

After leaving the Colorado School of Mines, young Davis went to Chile where he was employed by the Braden Copper Company. Upon his return to the United States he went with the Federal Zinc Company. He worked in the lead mines of Missouri for a while, and then was attracted to Florida at the time that state was experiencing its big boom days. He was engaged in engineering work in and around Tampa for two years, leaving this position to go to Buffalo, New York. At the time of his death, Mr. Davis was in the engineering department of the Travelers Insurance Co. at Buffalo.

The deceased is survived by his parents, his widow and a baby daughter now two years old. It was through communication with Mr. Davis' father in Washington, D. C. that the Association learned of his death.

"It Happned in Monterrey" And Not Such A Long Time Ago

And here is the account of the big All-Mexico celebration of which we had word before the June issue came out, but of which no details had been received in time to make that issue. Judging from Secretary Sada's letter, the meeting must have been a great success—in more ways than one.

MINES men in Mexico assembled in Monterrey May 17 for a great gala night. Seventeen Alumni from Matehuala, Cararon, Laredo, Cerralbo and all points near Monterrey, responded to the invitation sent out by Mines' only foreign Alumni section to join in an All-Mexico jubilee the night following the School of Mines commencement. The meeting was held at the Quinta Calderon in Monterrey.

It seems that the fun began almost at the very moment of the first visitor's arrival—but let us give you the story in Pablo M. Sada's own words as it was written by him:

"First, we went around to the different hotels and picked the visitors up and took them around to see the sights and have a good old Carta Blanca. Then we all gathered at the Foreign Club and had one to Mines and Old Times. Next came the eats.

"U. H. Berthier acted as toast-master and started the doings with a BIG "M-I!" You must have heard that way up in the States. Then followed a "Rip 'em up, Tear 'em up," and spirits began to soar high. We were all feeling just right when the Penoles Band started playing "The Mining Engineer." Then it was a riot! Had there been any Boulder guys around we should have been thrown in jail for murder. A great surprise from Berthier and his band that was.

"Well, we had another toast to Mines and after we all quieted down to a revolution, *Presidente* Fidel C. Martinez gave a short speech of welcome to the visiting members followed by a long applause. A toast to Fidel! A telegram of congratulation from the Parent organization was read and the whole bunch gave a skyrocket for Secretary Colburn. The telegram sent by us to the annual meeting at Denver was also read and approved unanimously."

After the dinner was over, several matters were taken up and resolutions were passed accordingly. They are as follows:

That an annual meeting be held in the City of Monterrey, Mexico, of all Alumni of the Colorado School of Mines residing in Mexico on the Saturday following commencement at Golden. This event sponsored by the Monterrey Section of the Colorado School of Mines Alumni Association, and that beginning with the next one all Miners should bring their wives and sweethearts (I should say their wives *or* sweethearts, not both) to the meeting and banquet.

At the motion of President Fidel C. Martinez, the resolution was passed that the Monterrey Section shall be ever ready to assist to the best of its ability in the Foundation campaign now being conducted at the School of Mines, and that this resolution be made known to the General Secretary of the Alumni Association for whatever use he may desire to make of it.

That monthly meetings shall be held regularly the second Saturday of each month at 8 p. m. at the Monterrey Foreign Club.

That all Miners residing in Mexico be urged to join the Alumni Association and the Monterrey Section.

Letters read at the banquet in answer to the invitation sent out by the Monterrey Section to all Miners in Mexico were received from: Ricardo Villarreal, '28; R. J. Wygle, '25; Edmund Stein, '13; S. J. Clausen Jr., '11; J. M. Garza Aldape, '05; and H. E. Nyberg, '06.

(Continued on page 28)

After the Banquet at Monterrey. The Mexico Alumni. Back row: Dallmus, Valdez, McKinless, Feizel, Skeahan, Ornelas, Gonzalez, Chapa, Urteaga, and Haight. Front row: Kaufman, Sada, Brown, Martinez, Robinson, Berthier, and Campbell.

Fatal Accident Takes Alumnus

DUANE C. KELSO

Duane C. Kelso, who was graduated from Mines in 1910, died June 22 as a result of fatal injuries received in an automobile accident a few miles north of Ft. Collins, Colorado. Mr. Kelso lived ten days following the accident, but all efforts to relieve his paralyzed condition, which resulted from the fatal crash, were of no avail. An operation was performed June 16 in an attempt to ascertain the real cause of the paralysis, but it did not succeed in saving his life.

Mr. Kelso was born at Lincoln, Kansas, on September 4, 1885. He moved to Denver, Colo., with his family while yet six years old, and lived there until completing his work at the Colorado School of Mines in 1910.

He was with the Union Oil Company for six years, in the Gas department. About a year ago he became associated with the Colorado Agricultural College, and in the fall went into classes part of the time, working the balance of the time for different departments. Just before his accident he went on duty full time with the Irrigation department. From the time of graduation from the School of Mines until 1922 he followed mining engineering, but in 1922 gave it up because of a break down in health. Upon his recovery from his illness he went into the oil development work just starting then near Fort Collins, Colorado.

Mr. Kelso was an active member of the Alumni Association, and an enthusiastic booster for Mines. He was one of the dependable boosters for the Mines Christian Association, and gave this organization both moral and financial support at all times.

Mr. Kelso was buried with the Masonic ceremony at the Crown Hill Cemetery, Denver. He is survived by his wife and two daughters, Jane and Esther.

Two prominent professors from schools in U. S. S. R. who recently visited the Colorado School of Mines to inspect the School. Reading left to right: C. H. C. Braden, Director of Publications, C. S. M.; Boris I. Rosov, visiting Professor of Metallurgy from U. S. S. R.; Inez G. Hintze, Assistant Director of Publications, C. S. M.; Fred Brenner, Interpreter; and D. M. Chijikov, other visiting Professor.

Students on Job Until July 5

Commencement exercises do not mean the end of the school year at the Colorado School of Mines. Only the seniors are through when the diplomas are given out. All others must continue for six more weeks.

The freshmen are busy with surveying courses in and around Golden. Over seventy men are still in town doing work that follows the commencement program.

Junior geologists are engaged in field work at Wild Horse Park near Pueblo, and the mining men are busy doing mine surveying at the school's experimental mine at Idaho Springs. The sophomores are in camp at Fort Logan.

The School of Mines begins its regular term the first of September and ends it, for all except seniors, July 5. Independence day is given as a holiday every year. This summer field work is a part of the regular session, and is not a summer school term. The summer school term itself begins June 30, overlapping by five days the regular session.

Eighty future officers of the U. S. Army engineering corps, all members of the School of Mines R. O. T. C., are taking intensive military training at Fort Logan. The camp started May 24. The embryo officers will remain at Fort Logan until June 24, when they will move to Rifle Range for 10 days target practice. Captain Heston Cole is in command of the R. O. T. C. camp, with Lieut. H. V. Canan and Sergeant Pat Meagher as his assistants.

The Hills and Pleasant Dells

Oh Lord of Hosts whose claim I boast
To be all right with all my might,
Bring forth thy wines from all the mines
Where nature's drink seeps through the brink
Of solid ores to drip through pores
Of lonely hills and pleasant dells!

What matters now for all I care
That glorious dame has brought me shame
By making eyes and telling lies
With love at stake—ah, sad mistake!
Alas for me, for all I see
Shall be the hills and pleasant dells!

I'll work the drift with all the thrift
Of mining men and all their ken.
Bring on the drop, for I'll not flop
When mines cave in and rock with din
To toll the way of parting day
Among the hills and pleasant dells!

When man has cried, 'Lord save my hide!'
I will not shrink to death's fair drink
But will await my phantom fate
Deep in the mine in all the slime
Where man was made with pick and spade
Among the hills and pleasant dells.

Oh Lord of Hosts, whose claim I boast
To be all right with all my might,
When duty calls amid the falls
Of all the stones, and life condones,
I'll be there to see you where
Are mighty hills and pleasant dells.

—*Tommie Northrup*, '32

Figuring the Slope in the Corner of a Bin

By FRED C. BOND, '22

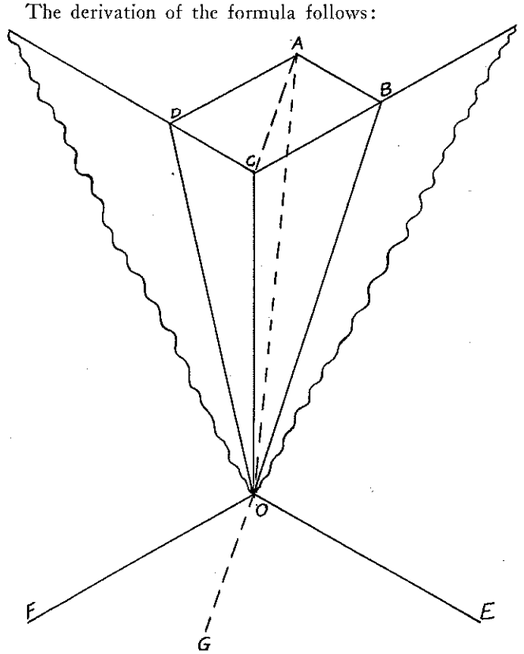
The slope in the corner of a bin or chute is of considerable importance. It should exceed the angle of repose of the material to be handled by a safe margin; otherwise there is danger that the material may hang up in the corners instead of running freely.

This slope is usually found either by graphical methods or by a somewhat laborious calculation. The following formula will apply to most conditions and will simplify the calculation.

$$\tan S = \sqrt{\frac{\tan^2 S_1 \times \tan^2 S_2}{\tan^2 S_1 + \tan^2 S_2}}$$

where S is the angle of slope in the corner, and S_1 and S_2 are the angles of slope of the two intersecting sides. All of the angles are measured in vertical planes in degrees from the horizontal. The formula will apply to all bin corners the traces of whose intersecting surfaces on a horizontal plane meet at an angle of 90°. The two intersecting surfaces may have the same or different slopes from the horizontal.

The derivation of the formula follows:



In Fig. 1 angle FOD = slope of one side of bin = angle ADO

and angle EOB = slope of adjacent side = angle ABO.

Angle DAO = angle BAO = 90°.

The following lines are horizontal: AD, AB, AC, OF, OE, OG. Line OA is vertical.

$$\text{Now } AD = CB = \frac{AO}{\tan FOD}$$

$$\text{and } AB = CD = \frac{AO}{\tan EOB}$$

$$\text{Therefore } AC = \sqrt{(AD)^2 + (CD)^2}$$

$$= \sqrt{\left(\frac{AO}{\tan FOD}\right)^2 + \left(\frac{AO}{\tan EOB}\right)^2}$$

$$\tan OCA = \frac{AO}{AC}$$

$$= \frac{AO}{\sqrt{\left(\frac{AO}{\tan FOD}\right)^2 + \left(\frac{AO}{\tan EOB}\right)^2}}$$

$$= \sqrt{\frac{\tan^2 EOB \times \tan^2 FOD}{\tan^2 EOB + \tan^2 FOD}}$$

But angle OCA = angle COG = angle of slope in the bin corner, Therefore

$$\tan S = \sqrt{\frac{\tan^2 S_1 \times \tan^2 S_2}{\tan^2 S_1 + \tan^2 S_2}}$$

The following table has been computed with the aid of the formula:

SLOPES

First Side	Adjacent Side	Included Corner
40°	40°	30°-41′
45°	45°	35°-16′
50°	50°	40°-7′
60°	60°	50°-46′
40°	50°	34°-27′
50°	60°	43°-57′

Heads Federal M. & S. Co.

H. G. Washburn, graduate of the Colorado School of Mines in 1904, was appointed in April general manager of the Federal Mining and Smelting company. Washburn had been assistant general manager of the company for five years.

The career of H. G. Washburn since leaving the School of Mines has been notable for its success and for his continuous connection with one organization. He was graduated in 1904 and soon after entered the service of the American Smelting and Refinery company as a mining engineer and was sent to southeastern Missouri to join the engineering staff of the Federal Lead company, a subsidiary of the A. S. & R., with headquarters at Farmington. He continued until 1913 as engineer for the company, which was rapidly expanding its operations, finally becoming the largest lead producer in the United States.

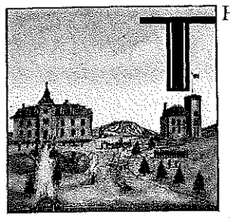
He was then advanced to general manager of the Federal Lead company. Mr. Washburn held this position until 1923, when the vast mining properties of Federal Lead in southeastern Missouri were sold to St. Joseph Lead company. Upon the final transfer of the properties, Mr. Washburn went to Salt Lake City, where he remained a little more than a year in the service of the American Smelting and Refining company. In 1925 he was appointed assistant general manager of the Federal Mining and Smelting company, also a subsidiary of A. S. & R., and he arrived in Wallace in the latter part of April of that year to take up his work.

Washburn will be located in Wallace, Idaho, which is the field headquarters of the Federal company. From here he will direct the farflung activities of an organization which includes many mines in the Tri-State district and large operations in the Coeur d' Alene district.

Colorado and Its School of Mines

By M. R. BUDD, '24

Part XII-School year, 1875-76



THE 1875-1876 term opened with the school short of funds and hoping for a substantial appropriation from the Legislature in 1876. Little of interest transpired in 1875; the attendance was low but the spirit was high. Good instruction was offered by practically the same faculty of 1874. Another paper was started by students of Jarvis Hall, which was composed and printed by students on their own presses. It was supported by voluntary contributions; there was no regular date of issue. (Both seem to go hand in hand even today).

Golden citizens repaired the road to Jarvis Hall in November. In the meantime, the City of Golden had been incorporated and was a prosperous community. There were three flour mills, with an annual output valued at $200,000; two coal mines, a paper mill, a brick works, two hotels, and a half dozen churches.

With the professor in charge receiving a salary of $100 per month and 50% of receipts from assays, chemical tests, and mine examinations, it is not difficult to imagine that in those days of appropriations and bitter factional strife, the school was never in a comfortable financial position.

It had a devout friend, however, in Gov. John L. Routt, last of the territorial governors, and a man who was interested in mining. Routt County was named for him—and he will always be remembered in Colorado as one of the ablest executives to sit in the governor's chair.

Disappointed indeed, was Golden when it read Gov. Routt's message to the Legislature in 1876. With high praise for education in general and for the University of Colorado in particular, Golden citizens were enraged when their supposed friend failed even to mention the School of Mines in his message.

But the mystery soon came to light. The governor sent a stirring special message to the Legislature a few days later, demanding that the School of Mines receive adequate support. He explained that the school was not mentioned in his general message because he had not received the report of the board of trustees. This was caused by the illness of Capt. Berthoud, who composed the report on a sick bed and convinced the governor of the school's needs.

The appropriation bill for 1876-1877 called for only $3,500, but several other points are noted in the act. One notices for the first time that tuition shall be free to *bona fide* residents of Colorado. How often this has been disputed and caused the school many, many arguments—and even litigation! The act, which was passed at the 11th Session of the Territorial Assembly and which is printed on Page 159 of the laws for that year, is as follows:

AN ACT

To provide for the several expenses of the Territorial School of Mines for the years 1876 and 1877.

Section 1. That for the purpose of providing for the several expenses of the Territorial School of Mines established near Golden, Jefferson County, Colorado Territory, for the years 1876 and 1877 the sum of $3,500 is hereby appropriated out of any funds in the Territorial treasury not otherwise appropriated;

Provided That tuition in said school, of Mines shall be free to *bona fide* residents of Colorado.

Section 2. The amount appropriated by Section 1 of this act shall be disbursed by the Board of Trustees of the Territorial School of Mines, as provided for in an act entitled "An Act to Establish a School of Mines" (approved) Feb. 9, 1874; *Provided,* That the professor in charge of said School of Mines shall perform the duties of a Territorial assayer . . . but shall not be entitled to receive for making assays or furnishing abstracts of the same any sum of money other than that specified by the Board of Trustees of said School of Mines; and such sum or sums of money so received shall form part of the receipts of said School of Mines, to be accounted for as such. Approved Feb. 11, 1876.

LAST TERRITORIAL BOARD APPOINTED

Gov. Routt appointed the last Territorial Board of Trustees early in 1876 and the first meeting was held in Golden on Feb. 15, 1876. Colorado was about to become a state; already it was assured that the matter would be favorably voted on, despite strenuous objections of the Transcript editor. Fossett's History of Colorado, published in 1876, in celebration of Colorado's admission to the Union, contains the following information about the School of Mines:

"Professor Gregory Board, Principal of the instructive department, is a thoroughly educated chemist and metallurgist, from the London School of Mines, and is aided by an efficient lady assistant. Twenty-one students have been receiving instruction besides a large class who have for two winters attended full courses of lectures in Chemistry, Geology, Blowpipe Analysis and Metallurgy."

The board, meeting in February, 1876, authorized the professor in charge, with "the assistance of men of suitable attainments", to examine candidates and grant diplomas. No degree was given, however, until 1883. It was also decided to hold two terms per year, instead of three.

Following is complete information concerning the school and its personnel in 1876:

Board of Trustees—Hon. W. A. H. Loveland, Golden, Jefferson County; Hon. Alpheus Wright, Boulder, Boulder County; Hon. N. P. Hill, Black Hawk, Gilpin County; W. W. Ware, Georgetown, Clear Creek County; Hon. Adair Wilson, Del Norte, Rio Grande County; J. H. Yonley, Montezuma, Summit County; Capt. J. T. Smith, Denver, Arapahoe County.

Executive Committee—W. A. H. Loveland, Alpheus Wright, James T. Smith.

Officers—President, W. A. H. Loveland; Secretary, Ed. L. Berthoud.

Faculty—Prof. Gregory Board, E.M.; E. L. Berthoud, C.E.; Richard Pierce, F.G.S.; Theodore Van Wagenen, M.E.; James Teal, M.E.; Wm. West, E.J.; Rev. Thos. Bellam, A.M.; Wm. Kendrick, Instructor in Telegraphy.

Course of Studies—First Term—Chemistry, theoretical and practical; Blowpipe Analysis and Assaying; Mineralogy; Drawing; Civil Engineering.

(Continued on page 37)

The Two-Fold Purpose of A Mining School

(Continued from page 7)

complished at the plant. The Climax Company operates today the largest molybdenum mine in the world, producing about 90 per cent of the world's supply.

Another field in which the Colorado School of Mines has been conducting much research is in the application of geophysics to practical prospecting. In this activity Colorado Mines is the pioneer, being the first school in the United States to teach applied geophysics and the only institution today offering a complete course in geophysical methods of prospecting.

In 1927, when the United States bureau of mines decided to begin a study of geophysical methods of prospecting, "with the special object of determining which geophysical method or methods would be the most economical and successful in a particular district," the Colorado School of Mines was called upon to furnish equipment and two experts, members of the school faculty, for the task. The results of this work have been published in a United States bureau of mines technical paper (No. 439), entitled, "Geophysical Investigation at Caribou, Colorado," and may be referred to by those who may be interested in the results of this research project.

The Edgar Mine at Idaho Springs, Colorado, is maintained by the Colorado School of Mines as an experimental mine. This mine is not only used for undergraduate work in mining which cannot be taught in the classroom or in the regular college laboratories. It provides a place for the carrying on of mine research and experimental work covering all phases of mining which permit of further development and increased efficiency. The school welcomes the use of this experimental mine by those companies having problems to solve or tests to make. A complete description of the mine and its equipment is impossible here. This information, however, has been published elsewhere[1] by the school and is available to those who may request it.

In addition to the research that is being conducted by the departments mentioned above and by all other departments, the Colorado School of Mines is co-operating, in the same manner as other western mining schools are doing, with its state geological survey in mapping the geology of Colorado with a view to the opening up of new mineralized areas.

Results of Research Are Published

Through its department of publications, the School of Mines publishes the results of research conducted by graduate students and the members of the faculty. Worthy theses and other long articles of interest to those connected with the mineral industries are published in the Colorado School of Mines Quarterly. A complete list of all the school's publications[2] has been compiled for the convenience of those seeking information relating to a particular field. It is believed that the School of Mines is rendering a worth-while service to the mineral industries in thus making public the results of research conducted at the institution.

The Greatest Contribution

The Colorado School of Mines is contributing its mite toward the advencement of the mineral industries by training men to solve the problems confronting these industries; it is contributing something more tangible, perhaps, from its research laboratories, but the greatest contribution of all, and the one in which the school takes the greatest pride, is the success of its graduates.

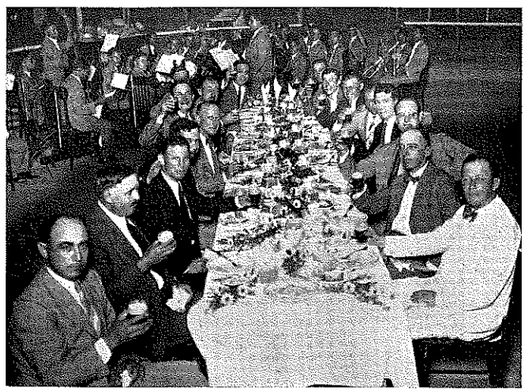
Since 1874, the official date of its founding, the Colorado School of Mines has granted over 1,600 degrees; and of this number there are many who have achieved success. School of Mines alumni hold high executive positions in some of the largest companies operating in the United States, Mexico, Africa, China and South America, while the soviet government has chosen several School of Mines men to assist in its industrialization of Russia. Two of the western mining schools are headed by graduates of the Colorado School of Mines, and alumni of this institution hold many government and state positions of responsibility.

The average visitor, admiring the beauty of the vine-clad buildings and the contrast which they make against the rugged mountainous background, may see in the Colorado School of Mines nothing more than just "another college." But a beautifully engraved gold case determines in no way the precision of a watch; it is the works within that count—and so it is with a college.

[1]—The Experimental Mine, by J. Burns Read and James Underhill. Colorado School of Mines Quarterly, April, 1930. Golden, Colorado.
[2]—Index to the Colorado School of Mines Publications, compiled by M. R. Budd. C. S. M. Quarterly, Vol. 23, No. 3. Golden, Colorado.

It Happened in Monterrey

(Continued from page 24)



At the Banquet Table

The pictures here show the Banquet in progress and a restful scene following the dinner. There was a third picture taken before the banquet, but along side these two it would lose its interest, and so it is not reproduced here.

According to the *Tampico Tribune,* a paper published in English, the Monterrey annual meeting must have attracted wide attention in Mexico. The *Tribune* states that the meeting lasted from 8:30 p. m. until 2:00 o'clock in the morning.

"It is important to have accurate knowledge, to have mastery of the facts involved in the issue at hand, but knowledge becomes but lumber if its possessor cannot analyze it, assess it, relate its varied parts intelligently, and steer the issue at hand past all irrelevant factors and bring it out into the sunlight. In short, it helps but little to know much if we cannot think straight about what we know."—*Glen Frank.*

Dean Jesse Morgan and his mother, Mrs. Douglass Morgan, left June 17 for a week's trip through Yellowstone.

News from the Chapters

An Apology to the Great Lakes Section

The fact that the Great Lakes Section received no advance word of the seniors' visit to Chicago last April has just been brought to the attention of the Editor. Such an oversight on the part of the managers of the trip is to be regretted.

A letter, which is printed here, from A. L. Lynne, '06, president of the Great Lakes Section, brought the information of this oversight to the attention of the Magazine. The Editor, however, wishes to assure Mr. Lynne and the Great Lakes Alumni that nothing in the article in the June issue of the Magazine, telling of the senior trips, was directed at the Great Lakes Section.

A student, who was one of the party making the tour, reported the trip for the Oredigger and the Magazine. The reference to the "frigidity of the Windy City" was directed at the Chicago hotels. This was altered when edited for the Magazine. The alteration renders the original statement incomplete and unintentionally makes possible an interpretation which can be taken as an insult to the Great Lakes Section.

The Editor assumes full responsibility for the incompleteness of this reference. If a part of it was to have been struck out, all of it should have been.

Here is Mr. Lynne's letter:

June 16, 1930

Dear Colburn:

In the June issue of the Alumni Magazine, there is a statement criticising the "frigid treatment" of the Great Lakes Section toward the students and professors who recently made a metallurgical trip to Chicago and vicinity.

The Great Lakes Section had written to President Coolbaugh regarding what they considered neglect on the part of either the Colorado School of Mines, or some of its professors. We know that had we had the necessary information that Chicago would have done its part toward entertaining the boys.

Under date of June 13, President Coolbaugh wrote us as per copy attached hereto, and in fairness to the Great Lakes Section, we suggest that the matter be properly placed in the Alumni Magazine in one of its early issues, with this letter of President Coolbaugh's printed.

As a matter of further information, we are also enclosing herewith, a copy of our letter of June 6 to President Coolbaugh, wherein we expressed ourselves rather frankly to him regarding this entire matter.

We would like to know how the St. Louis Section knew of the anticipated arrival of the boys in time to prepare for their entertainment and why similar information was not given to the Great Lakes Section.

Yours very truly,
GREAT LAKES SECTION
A. L. Lynne,
President.

President Coolbaugh's letter referred to in Mr. Lynne's communication to the Alumni Secretary is as follows:

June 13, 1930

Dear Mr. Lynne:

I am very sorry indeed that our professors and students did not get in touch with the Great Lakes Section of the Alumni Association. This was an oversight, I am sure.

The trip was arranged somewhat hurriedly, and every effort was made to get the maximum time for inspection of mining and metallurgical processes. Professor Carpenter was in charge of this trip, and I know that he would not intentionally slight any local section. He is not at the present time in Golden so I do not have an opportunity to talk to him on the subject. I am expecting to bring this matter to his attention, and I am sure that no eastern trip will be made in the future which does not contact the Great Lakes Section.

With kindest regards and best wishes, I am,

Cordially yours,
M. F. Coolbaugh

New York Section

The 92nd regular meeting of the New York Section of the Colorado School of Mines Alumni Association was held at the Chemists' Club, 52 East 41st Street, New York City, on Friday, May 9, 1930. Dinner was served at 6:30 P. M.

The following men were present:

Bevan, J. G., '21, 3771 Tenth Ave., N. Y. C.; Bladholm, E. F., '29, 220 E. 18th St., N. Y. C.; Burgess, C. W., '09, 247 Park Ave., N. Y. C.; Brown, F. A., '21, 98 St. Marks Pl., Staten Island; Downes, F. A., '13, 247 Park Ave., N. Y. C.; French, C. L., '13, 11 Bartlett St., Brooklyn, N. Y.; Frondel, C., '29, Bayside, L. I.; Lowe, Rupert, '22, 247 Park Ave., N. Y. C.; McKinless, F. V., '23, 11 Broadway, N. Y. C.; Miller, A. L., '17, 230 Park Ave., N. Y. C.; Paul, R. B., '02, 160 Front St., N. Y. C.; Pilger, T., Ex-'10, 55 Wall St., N. Y. C.; Spicer, C. A., '05, Los Angeles, Calif.; Taylor, L. S., '26, 247 Park Ave., N. Y. C.; Wolf, H. J., '03, 42 Broadway, N. Y. C.

Mr. H. G. Einstein—Guest Speaker.

Following the dinner President Wolf called the meeting to order. The reading of the minutes of the previous meeting was dispensed with. The Treasurer's report was read and accepted.

A letter from the Monterrey Section was read and we are pleased to note the activity of the only section operating in a foreign country.

The guest speaker of the evening was Mr. Herbert G. Einstein, of H. G. Einstein & Co., Members of the New York Stock Exchange and the New York Curb Exchange, who outlined in a most interesting and instructive manner the methods of procedure in a well-regulated brokerage house. Mr. Einstein pointed out many of the mechanical details of the modern Wall Street machinery involved in the rapid and accurate execution of orders and contracts between brokers and their customers. He emphasized the high standards of ethics maintained in the operation of leading stock exchanges. On this subject he was well qualified to speak, having had nearly thirty years of active experience in the brokerage business and having been instrumental in the erection of the new Curb Exchange and in its rapid progress during the past ten years.

The address, and subsequent discussion of the questions asked by those present, extended over a period of two hours without tiring the audience, which indicates that mining engineers may become interested even in the highly technical details of professions beyond the horizon of their own activities.

The meeting was adjourned at 10:30 P. M.

High School Graduates Choose Mines

Out of six young men of the Golden High School graduating class who have selected to go to college, four of them have chosen the School of Mines. They are: James Hutchison, Howard Delaney, Lysle Straight, and William Voz. This is a good percentage recorded for Mines.

The following graduates of East High School, Denver, have designated the School of Mines as their choice of a college. They will enter this fall. John F. Bumpus, David W. Chase, Jack H. Collins, Eugene C. Frost, Robert L. Middlekauff, Lowell O'Daniel, Lowell A. Patterson, Anthony Pecukaitis, Abe D. Swedlow.

East High male graduates chose Colorado schools as follows: Eleven will attend Aggies; four will go to Colorado College; Denver University claims thirty-eight, and forty-two will attend the University at Boulder.

In view of the fact that Mines is strictly engineering, ten students from East is not out of proportion with the numbers going to other colleges in the State.

Mines is to have a new athletic field, it was announced Wednesday by Dr. M. F. Coolbaugh, president of the School.

Need for an auxiliary field to Brooks has been felt for some time. Freshman football practice and baseball contests will be held there.

The new field is to the south of the experimental plant, and has been used at times as a civic playground. Funds for the improvement of the new grounds have been subscribed by the School of Mines, and other organizations.

It is hoped to have the new grounds ready for fall use.

Twenty-five Mines students, directed by Prof. J. Harlan Johnson, Prof. W. P. Huleatt and Prof. Quenton L. Brewer, are to return Sunday from a geological field trip through Southern Colorado and New Mexico. They leave Monday for Idaho Springs where they will remain two weeks to complete the field course.

A man called the family cat "Carbide" because she had a set o'lean kittens.

Alumni Letters

32 E. Delason Ave.,
Youngstown, Ohio,
June 17th, 1930.

Dear Colburn:—

I am in receipt of a statement for dues and subscription to the Magazine, sent June 1. I have been intending to send my dues ever since pay day, but then it is said that Hell is paved with good intentions. Anyhow, you will find those paving blocks enclosed—hope they come in handy.

There are three Mines men here including myself. A. W. Smith, '14, is general superintendent of the Campbell Works, Youngstown Sheet and Tube Company here; and F. M. Reubendale, '24, is a metallurgist employed by the Republic Iron and Steel Corporation in their Youngstown plant. Some day, I have hopes of establishing an Alumni Chapter here but so far it appears improbable. Next to mining men, steel workers are a migratory lot, at least in their youth. There are a number of the gang in the Pittsburgh District, and a couple in Stuebenville on the Ohio river but with the exception of Percy Echols, '27, I have seen none of them to date. Echols is working for the Winton Steel Company at Stuebenville.

Just today, I received a wire from "Red" Wallis, '28, who is in the States on his vacation, that he will be with me on the nineteenth for a session. Haven't seen him for over two years and it will be a treat. Incidentally, I wish to broadcast the information that Youngstown is a full grown metropolis—we even have political graft now, and we have four railroad stations. "Red" wired me that he would arrive at 7:20 A. M., blissfully ignorant of the fact that three trains from Chicago arrive at the same time here, in different parts of town! I am not triplets and unless I am lucky in choosing the right station he won't have a reception committee. I might add here that Evans Jones, '31, pulled the same trick on me a couple of months ago when he left the Junior inspection trip in St. Louis to take a run up here. I hate to meet trains early in the morning at the best, but not knowing whether or not one is in the proper station is adding insult to injury. Hope all my friends see this and keep it in mind when they decide to pay me a visit.

Had better sign off now. I will be in Golden in July and hope to be able to drop in at the office sometime before I leave.

Sincerely yours,
ED. BITZER, '29.

Long Beach, California
June 4, 1930.

Dear Colburn,

Several weeks ago I was attending an aeroplane circus at the Municipal Airport in Long Beach and whom did I run across but Sidney Ross, class of '25. Sidney is now holding the position of pilot and instructor for the O'Donnell School of Aviation, Long Beach. It will be remembered that before attending "Mines" Ross flew for the Canadian Air Forces during the World War. It will also be interesting to former classmates of Sidney to know that "Duke", his German police dog pal of campus days, is still with him.

I wish to take this opportunity to notify your office of my recent change of address. It is now 357-B Obispo Ave., Long Beach, California.

Congratulations on the splendid magazine you are continuing to send out.

Sincerely yours,
L. A. SHAW, '25.

Johannesburg, Transvaal
1st May, 1930.

Dear Mr. Colburn,

Yours of March 20 only arrived by the last mail when it was too late for my reply to reach you before the fifteenth of May.

Many thanks for your kind invitation to attend the annual meeting which I much regret being unable to accept, especially owing to the fact that you expected many of my old classmates, to meet any of whom would have been a great pleasure to me.

Being such a distance from Golden, and such a long time having passed since leaving there, I find it difficult to keep in touch with events, but the Magazine is a great help in this respect and I enjoy it very much. I think it a great success and heartily congratulate all those responsible for its production.

A letter from you enclosing Ballot Papers also arrived but as this will not reach you until long after the annual meeting I am not voting.

With kind regards and very best wishes.

Yours sincerely,
F. A. G. MAXWELL, '95.

Sverdlovsk, U. S. S. R.
May 24, 1930.

Dear Colburn:

Just a note to get a change of address. I have been transferred to the large lead-zinc mine at Ridder, and my address for the ensuing year will be:

L. M. Banks, Ridderzinc, Ridder, U.S.S.R.

I understand that Harry Wilson, '16, is there on metallurgical work now; also two or three other Americans.

While in Moscow recently on a business trip I met Byron Johnson, '08, who is metallurgist for the copper mines in the southern part of the country and H. W. C. Prommel, Ex-'20, who is reorganizing the geological department of the Tzvetmetzoloto.

Kaanta, '15, is still at Bogomol and is one of the four pioneer American engineers in the employ of the Soviet. He has been here for two years or more. He has done some good work for them and is highly respected.

Tedrow, formerly of Breckenridge, Colorado, came in just as I was leaving Moscow so I only saw him for a few moments. He will be stationed in the Sverdlovsk district—the center of mining activities of the Ural Mountains.

With kindest personal regards and best wishes,

Sincerely,
L. M. BANKS, '12.

Uralmedstroy-Perm Railroad,
Station Verhnija,
Novo Levinsky Mine,
U. S. S. R.,
May 30, 1930.

Dear Mr. Colburn:—

I am located as per above in the Ural Mountains. Latitude 60° N. and Longitude 60° E. These mountains are unlike the ranges in the States for they are nothing but hills.

I want to correct an error about not bringing your personal necessities into this country. On the contrary, bring all your necessary clothing as I find things hard to get here.

There are many Americans over here now and also among them are our C. S. M. boys. Met Mr. H. W. C. Prommel, at Moscow who is Geologist for the Government. Mr. Byron M. Johnson is also with him and a Golden man. At the Uralmedstroy, where I now am, is Mr. Kaanta, Consulting Metallurgist and a Golden man. He has put up a fine mill here of concrete. There are two copper mines here, two miles apart, and I am in charge of one while a Mr. Collins runs the other. In between is the mill and later on a smelter. In fact the mines and mills run together as one camp and has a population of 5,000 men, I am told.

All foreign engineers are treated fine here. But there are many things one must learn to be accustomed to in order to get along. One must practice much patience as their meaning of time and ours is different.

U. S. FOUNDRIES, Inc.

A. C. HOVEY, Pres. and Gen. Mgr. 3975 Williams Street, Denver

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For mantles and liners for ball mills

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Our specialty is

MOLLY-Chrome

STEEL CASTINGS

I have been rerouted from Siberia to this place because their proposed mining method I am acquainted with and have practiced while with the Kennecott Copper Corp. in Alaska.

Yours very truly,
CLARENCE WM. POY, '24.

Minas del Aguacate,
May 25th, 1930.

Dear Mr. Colburn:

Thus belatedly I answer your kind letter of March 29 as well as several others which really required no answer, for all of which I thank you.

Living as I do away from Anglo-Saxon civilization and given the Latin temperament which controls things that be, it sometimes takes a long time for a letter to reach me. All of your letters and those of Mines come too late for a timely response as witness your letter telling of commencement and reunion on May 16! None the less, I value highly the attention and hope some day fittingly to correspond and to be able to do something for the School to which I am exclusively a debtor thus far in life. But, as they say in Spanish, "Man proposes and God disposes".

I want to tell you how much I admire your efforts and their evident result for the School, for the Association, and for all of us. You have given new life to an entity that appeared to be quite beyond hope. How you did it is far beyond me, but the fact is evident.

Again thanking you for your letter and for the list of addresses, please believe,

Very sincerely yours,
HAROLD HENRY JUCHEM, '10.

Files of Colorado's Oldest Weekly Newspaper are Source of Mines' History

The Colorado Transcript is the oldest Colorado weekly paper, founded in 1866 by General George West. The Transcript files are complete and from them may be gleaned the complete story of progress of Colorado from territorial days down to the present date.

It is interesting to note that the present editor of the Transcript, Neil West Kimball, is the grandson of General West. Editor Kimball once attended the School of Mines. When asked about his career at the School, he laughingly states that he received credit in Political Chemistry and Journalistic Mathematics, but flunked all other courses.

Two clippings from the "Do You Remember" column of the Transcript for June 19, 1930 are of interest to Miners:

THIRTY YEARS AGO THIS WEEK

"The School of Mines commencement exercises were held at the opera house. Twenty-seven diplomas were issued. The address was delivered by Professor Aaron Gove, of Denver."

SIXTY YEARS AGO THIS WEEK

"The foundation work for the School of Mines buildings was nearing completion, and work was also being pushed on the Jarvis Hall building."

It was a motorist who looked at the streets in Venice and asked, "How many gallons to the mile?"

Married Men Lead in Grades

Another problem for the socio-psychologist to solve—why do married men at the Colorado School of Mines make better grades consistently than the unmarried ones?

The fact that they do is borne out by figures released at the registrar's office. For the fifth consecutive year the benedicts have managed to keep in the lead with an average of 82.25 to that of 77.85 for their single brothers. In only one year—1927-1928—did the married men have a close call; they averaged 78.60 to the unmarried students' 77.60.

George Somers of Fort Wayne, Ind., the highest average for the married group with 96.73, and F. B. Glidden, sophomore, Madison, Wis., was second with an average of 95.69, the compilation showed.

The registrar's books for the year revealed that out of a student body of 420, 28 boast of having wives to aid and abet them in the pursuit of their studies.

Clipped from a California Paper

Los Angeles, May 7.—The California oil fields are accustomed to visitors hailing from all over the world. One of the most interesting groups to pay a recent visit was a party composed of ten members of the senior petroleum engineering class of the Colorado School of Mines. This famous Golden institution draws students from all over the country and has made a valuable contribution to the oil industry in offering an outstanding course in petroleum engineering.

At the Colorado School of Mines the practical side of petroleum is not neglected for theory. This trip, in which about two weeks were spent in a detailed study of California field and refinery methods, plays an important part in rounding out the course. While in Los Angeles, time was found to visit a few of the oil tool manufacturing plants. The party, under the direction of Professor B. B. Boatright, made a thorough and complete inspection of the Universal Engineering Company's Zublin Bit. Working models showing the drilling action of the Zublin Bit, together with the three types of Zublin Interchangeable Cutters, were found of particular interest.

Don't worry if your job is small
And your rewards are few,
Remember that the mighty oak
Was once a nut like you.

Turner at Berlin Conference

Scott Turner, Director of the United States Bureau of Mines, presented a paper on "The Economics of Coal Stripping," at the World Power Conference held in Berlin, Germany, this month. Mr. Turner's special qualifications for discussion of this subject are that in an extensive, widely varied mining engineering career he has had the opportunity of observing numerous notable stripping or open-pit mining operations, and that the Bureau of Mines, over which he presides, has conducted the most thorough study of the economics and technology of coal stripping ever made.

The fact that for twenty-five years Mr. Turner has practiced his profession of mining engineering in many parts of the world has necessarily given him somewhat of an international point of view. Mining interests have not only taken him through most of the western mining states of the United States and Alaska, but they have occupied his time for sixteen years in foreign countries, including Canada, various European nations and many republics in Central and South America.

Mr. Turner was a recent visitor to Colorado, having given the commencement address to the graduating engineers of the Colorado School of Mines, May 16.

Dames Have Treasure Hunt

Search for treasure is as engrossing to the wives and mothers of future engineers as to the men themselves.

As the first of three summer parties, the Dames club entertained at a treasure tea Saturday, June 21. Upon their arrival at the home of Mrs. W. J. Risley, 1522 Maple, the Dames were given the first mysterious clue of the group of six. The clues, which were rhymed, led the fortune-seeking Dames a merry chase over the campus. Guggenheim, Armstrong, the power house, gym, tennis courts, and finally a bend in the brook running by the Risley home, were the stations.

Mrs. Mary Wilson, Mrs. H. L. Hays, and Mrs. W. C. Miller, were the successful adventurers, finding the treasure tucked away in an old hat on the brook bank.

Mint tea and sandwiches were served the guests on the porch of the Risley home. Mrs. Alice Moore, Mrs. Mary Wilson, and Mrs. A. J. Hintze assisted the hostess. Don Risley also did his bit.

To the Industry—

If you need men write the

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Personal Notes

Fred C. Bond, '22, is to be in charge of the Mining Research Laboratory for the Allis-Chalmers company in West Allis, Wisconsin. His address is 485 Sixty-third street.

George W. Thomas, '26, Mrs. Thomas and children left Golden June 13 for an extended vacation in California. Thomas is a member of the Mines faculty in the chemistry department. He was graduated with the degree of Chemical Engineer. Mrs. Thomas is the daughter of "Court" Doolittle, for many years Registrar and Business Manager of the School.

Jerry Malkovsky, '30, has been away from Golden since graduation doing some geophysical consulting work in Rosiclare, Illinois. After a short visit in Toronto, Canada, he returned to Golden June 26.

Doctor Malkovsky will sail for Stockholm, July 26 as a representative at the American Geophysical Union meeting. He will present three papers on geophysics, two of Doctor Heiland's and one of his own. From Sweden he will go to Benesov, Czechoslovakia, to visit his people.

William Levings, '20, who received his master of science degree in May, sailed in June for South Africa where he is to be with the Sinclair Oil Company.

William Wallis, '30, and *Harold W. Haight,* '27, are with the Cia Transcontinental de Petrolia, S. A. Tampico, Mexico.

Ben F. Angus, '29, is receiving his mail at Geolkom, Moscow, Verkhnie Torgovye Riady, 3 Linia, U. S. S. R.

R. A. Morgan, '29, is in Pittsburgh, Pa., with the United States bureau of Mines station there.

Hugh Wallace, '28, was a Golden visitor last month. He is in the States on a two months' leave from Maracaibo, Venezuela, where he has been located since his graduation.

Jacob Schoder, Ex-Mines, arrived in Argentina, where he will hold an executive position with the St. Joseph Lead company. *William Schoder,* '22, his brother is employed in Cuba by the American Metals company.

Charles T. Baroch, '23, of the Bagdad Copper Corporation, Bagdad, Arizona, spent the week of June 8 in Denver, on his return trip from St. Louis where he attended the convention of the American Electrochemical Society, May 29 to 31. He presented a paper, "Hydrometallurgy of Copper, Bagdad Property". Other Mines men present at the Convention were *Reginald G. Bowman,* '11, *Floyd Belleau,* '23, and *Dr. F. W. Traphagen.*

Benjamin Arkin, '27, who has been with The Texas Company for the last two years recently received a promotion to Lubricating Engineer for Mexico, his address now being c/o Texaco, S. A., Apartado 2635, Mexico, D. F., Mexico.

Norman E. Maxwell, '17, has recently become associated with the Crew Levick Company of Philadelphia. His address is in care of this company, Titusville, Penna.

Christopher W. Ryan, '23, has returned to his home in Lynchburg, Virginia after several months travel in Europe.

Don M. Johnson, '29, is now Assistant Field Superintendent for the architectural firm of Phillip L. Small, Inc. His address is Box 116, The Greenbrier Hotel, White Sulphur Springs, West Va.

H. F. Parsons, '03, was honored with the degree of Civil Engineer at the Nebraska University commencement exercises last month.

Sidney Small, '17, was in Golden the week of May 18 looking up friends. Small had just returned from New York and was enroute to his home in Los Angeles, Calif.

John T. Stubbs, '26, is now connected with the Apure Venezuela Petroleum Corporation with address at No. 1 Plaza Flores, Puerto Cabello, Venezuela, S. A.

Norman Whitmore, '26, is associated with Dr. Gerard Henny under the firm name of Henny & Whitmore, Consulting Geologists and Mining Engineers, 1031 South Broadway, Los Angeles, California.

G. F. Kaufman, '21, recently accepted a position with the Compania de Petroleo Mercedes, S. A., Apartado 269, Monterrey, N. L., Mexico.

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L. H. Henderson, '28, *V. P. Pentegoff,* '28 and *T. F. Adams,* '29, compose Crew No. 1 of the Radiore Company of Los Angeles and are now doing Geophysical and Geological work in the southwest. *B. F. Angus,* '29, has gone to Russia for a year's work with a Radiore crew.

Clayton Kerr, '30, is now in Billings, Montana. He is employed by the Texas Production Co.

V. G. Gabriel, a graduate student at Mines, is doing some experimental work concerning magnetic effects of ore bodies. He is checking results against certain formulae he has devised in connection with this problem.

Roy B. Munroe, '29, is Industrial Engineer for the Kansas City Gas Co.

Young Munroe is the author of an article in the June 1930 issue of the Industrial Gas Journal. He describes the process of converting a heating plant to gas fuel.

This young graduate engineer is making remarkable progress in the engineering profession. He received his diploma only a year ago. He was the first in his class of 67, and received the Wolf medal for high scholastic achievement at the School of Mines commencement exercises in 1929.

H. F. Parsons, '03, received the degree of Civil Engineer, from the University of Nebraska in June. Since his graduation from Mines, he has been active in irrigation projects in Nebraska. His home is at Scottsbluff.

L. L. Middlekamp, '05, assistant general manager for the Cinco Minas Company, at Magdalena, Jalisco, Mexico, was a Mines visitor in June.

B. S. Butler, Hon. '29, called at Mines June 16. Mr. Butler does cooperative work with the U. S. Geological Survey. He read a paper before the Colorado Scientific Society, June 28.

Edward Borrego, Ex-'27, has received a promotion to district production superintendent for his company, the Huasteca Petroleum Company. He is stationed at Ebano, S.L.P., Mexico. The Ebano field is one of the most extensive operated by the company.

G. F. Kaufman, '21, who belongs to the Monterrey Section of the Alumni Association, has a new business address: Cia de Pet. Mercedes, S. A., Apartado 269, Monterrey, N. L. Mexico.

W. L. Cox, Ex-'25, is with the Prest O Lite Company in Seattle. His address is 6307 38th S. W.

Engagements and Weddings

Lonergan-Burkhardt

John D. Lonergan, who attended Mines a year ago, and Miss Helen Burkhardt were the principals in a lovely wedding at high noon, June 15 in Denver. Lonergan hails from Whiting, Indiana.

Patten-Teal

Reamer Patten and Mildred Hemberger Teal chose May 24 for their wedding day. Although they tried to keep the event a secret, friends of the couple discovered that they had been married at the Episcopal rectory in Golden. Mrs. Patten will remain in Golden until winter when she will join her husband in Steamboat Springs where he is following his profession of petroleum engineer. He is a graduate of '30, and a member of Sigma Phi Epsilon.

Hartkemeier-Schroer

Miners will be interested in the news of the marriage of L. W. Hartkemeier, associate professor of chemistry at the School, and Miss Dorothy Schroer, June 19, 1930. The wedding took place at Minneapolis, Minnesota. The newlyweds are planning to be in Golden by the middle of July.

BIRTHS

Getting his professional and his parental degree within a month is the record for H. J. Van der Veer, Class of '30. Peter Allen Van der Veer (Class of June 9, 1930) and his mother, who was Miss Janet Davidson, will leave the latter part of the summer to join "Van" in Durango where he has accepted a position with the A. S. & R.

* * *

Extra!—Editor Has New Assistant. Roberts Austin Braden arrived in Golden, June 12, just in time to help his Dad with the July issue of the Magazine. The very new assistant weighed eight and three-quarters pounds.

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