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STATE MINERALOGY: WHY, WHENCE AND WHITHER[1]

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ABSTRACT

State Mineralogical and Geological Surveys have a continuing responsibility to Government and have continuing obligations to the public which are by no means fulfilled, as has sometimes been assumed, with the completion of a state geologic map or the cataloging of a state's mineral occurrences. Continuity, of statistical records alone, is an important obligation, as are continuity of research programs and of publications. Government could take, and should have, a larger and more effective role in balancing the employment cycle for earth scientists and engineers, with beneficial results to the public, to private industry, and in the distribution of college enrollments. The need for public education in science in general and in mineral science in particular cannot be over-emphasized.

Members of the Mineralogical Society and guests:

In searching for explanations as to why an MSA Nominating Committee should have placed me in line for the presidency of this august society, I became convinced that the committee must have been bemused by my then title, "State Mineralogist"—the only such title in America—and was anxious to place on exhibit such a rare specimen. By the same token, it could be presumed that the nominating committee might later, in addition to displaying the specimen, want to hear from him concerning the functions of his office.

In this connection, it might here be of interest to note that of the 42 presidents our Society has had since its founding in 1920, 30 were college and university professors, five were with the Carnegie Geophysical Laboratory, three were with the U. S. Geological Survey, and four have been in miscellaneous categories such as the U. S. National Museum, U. S. Department of Agriculture, etc. But never before has there been a State Mineralogist in this office.

It was these considerations, obviously, that governed my choice of title, "State Mineralogy: Why, Whence and Whither," and in speaking to this topic you must permit me to draw upon my own state by way of background and illustration. To be sure, much of that to which I shall

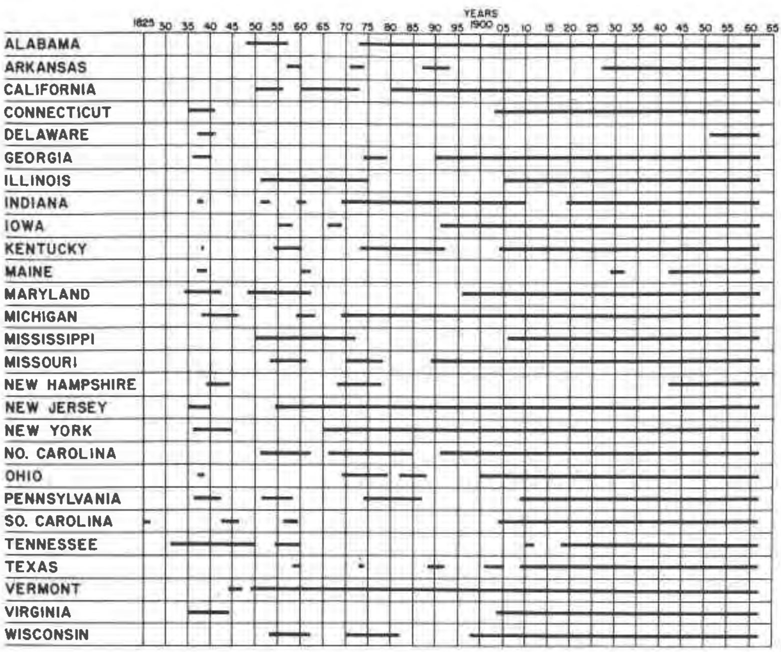
[1] Address of the retiring President of the Mineralogical Society of America at the 43rd annual meeting of the Society at Houston, Texas, November 13, 1962.

refer happened somewhat before my time, but it is a part of the history and tradition I have been privileged to inherit.

It all started, one might say, with the creation of an office of State Geologist in California in 1850. It is considerably to California's credit that she initiated such an office in her very first year of statehood. Equally, of course, credit should go to those states which had much earlier initiated geological surveys and demonstrated their value.

For the data upon which Fig. 1 is based, I am indebted to Dr. George Hanson, currently the historian of the Association of American State Geologists. He has brought together, in preliminary form (Hanson, 1962), a record of the dates and the many names under which State Geological and Mineralogical Surveys and related bureaus have operated. In Figure 1, for present purposes, the graphic record of operations is shown only for those states that initiated surveys prior to the Civil War. A more detailed chronology of the State Geological Surveys, complete up to 1950, was published by Leighton (1951, p. 573).

You will note that to South Carolina goes the credit for first initiating a state survey, even though it was rather short-lived. In terms of longev-



OPERATIVE STATE GEOLOGICAL SURVEYS
(ONLY THOSE SURVEYS BEGUN BEFORE THE CIVIL WAR ARE SHOWN)

FIG. 1.

FIG. 2. J. B. Trask, first State Geologist (1850–57) of California.

ity, Vermont with her 115 years of continuous operation stands at the top, followed by New Jersey, New York and Michigan. The California record, like so many which got off to an early start, shows some gaps but the gaps were never long, and we currently take much pride in the continuity of our operations since 1880.

Now to bring a few personalities into this record: California's first State Geologist was Dr. J. B. Trask (Fig. 2). As was true with so many in those days, he obtained his training and interest in natural science as the result of having taken a degree in medicine. Starting in 1850, he served as State Geologist for 7 years, until the legislature closed out the office; whereupon he returned to the east, made a distinguished record as a surgeon during the Civil War, and thenceforth continued in the medical profession. But it was not long until a geological survey in California was reconstituted and one of the top men in his field obtained to direct it. The redoubtable J. D. Whitney had at various times already served on the State Surveys of Illinois, Iowa, Michigan, New Hampshire and Wisconsin, and he was the author of a notable volume on the mineral wealth of the United States. Despite the difficulties of the Civil War years, Whitney was able to attract some outstanding talent (Fig. 3) to serve on his new Survey. There was, for example, Clarence King who later directed the 40th Parallel Survey and still later became the first director of the U. S. Geological Survey. There was W. M. Gabb, later to become an internationally renowned paleontologist; Charles Hoffmann, who deserves to be called the father of modern topographical surveys; and William Henry Brewer, author of that delightful classic, "Up and Down California," who later became professor of agronomy at Yale and a president of the National Academy.

For various reasons (certainly not for lack of scientific talent!) the Whitney survey eventually ran into political difficulties. For example,

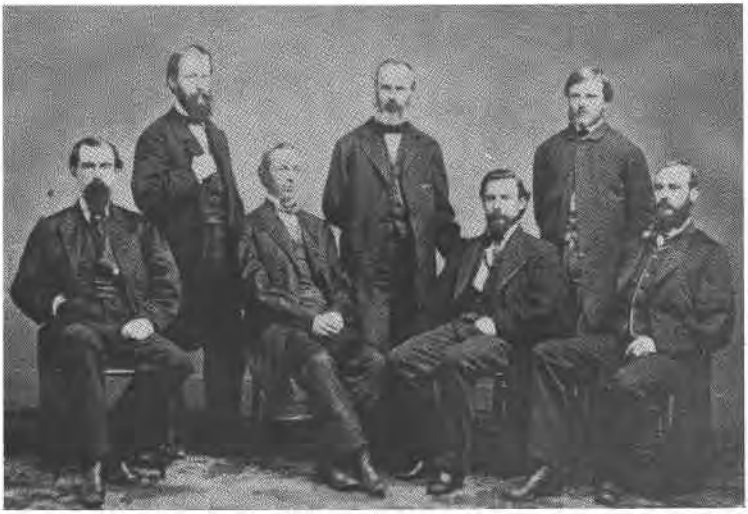


FIG. 3. The California State Geological Survey, December 1863. *Left to right:* Chester Averill, William M. Gabb, William Ashburner, Josiah D. Whitney, Charles F. Hoffman, Clarence King, William H. Brewer.

those who, understandably, felt that revitalization of gold mining was the immediate and the most important key to California's future, were highly unappreciative of one of the Survey's first major publications—a treatise on paleontology (Gabb, 1869) that we now recognize as one of the Whitney survey's significant contributions to the unravelling of California geology. And so in 1874 the State Geological Survey died on the vine for lack of legislative appropriations to nourish it. Or rather, it slowly withered away—for Whitney, then a professor at Harvard, actually utilized his own funds to complete some of the survey projects and to see them through to publication. This gives a true measure of the devotion of this public servant.

Within a few years the more thoughtful legislators had again recognized the value of maintaining an agency concerned with the geology and mineralogy of the state, which would be in a position to develop scientific and economic data, and to supply impartial reports. But geology and, even more so, paleontology, had become "bad words," so the re-established agency was given the name of "Mining Bureau," and to direct it a "State Mineralogist" was appointed. Through the years, however, the State Mineralogist has constantly been concerned with the same problems and the same projects that concern State Geologists, and for practical purposes the titles are virtually synonymous. The first State Mineralogist was Henry Hanks (Fig. 4), who took office in 1880, and for whom the mineral hanksite[1] was named. This was most appropriate, for

FIG. 4. Henry Hanks, first State Mineralogist (1880–85) of California.

Hanks himself had a good deal to do with some of the first borax developments in California and—perhaps prophetically—the production of borax has steadily increased until now it is one of the state's most valuable mineral commodities and constitutes its chief mineral export. At various times in subsequent years, changes have been made in the title of our agency: Mining Bureau, Division of Mines and Mining, Division of Mines, and currently Division of Mines and Geology, a change that came about a year ago and which led to a change in my title from State Mineralogist to State Geologist.

So much for history and "whence," for it is high time that I get to the "why" and "whither" in my title. Why have a state geological and mineralogical survey? Before answering that, let us first give some thought to the place of the mineral industry in our economy. It, along with agriculture and one or two others, is truly one of our basic industries. But just how basic? In Paleolithic times, agriculture and hunting and fishing were the truly basic industries—life itself depended on their successful pursuit. Stone work and such other mineral industries as were then getting their start were doubtless regarded as little more than luxuries. Certainly they weren't essential. But over the last 10,000 years, the mineral industries consistently have been gaining in importance. We can now say that the mineral industry is truly our most basic industry for, without the mineral

[1] Hanksite, of course, is not itself a borate mineral, but it is a distinctive mineral in the paragenesis of the Searles Lake deposits which have long been one of the two principal sources of commercial borates.

industry, modern agriculture would be impossible. Without non-metallic minerals to replenish our soils and without metal for the machinery to sow, to harvest, to process, and to distribute the increased crops that result from mineral fertilizers, man—in the numbers in which we have chosen now to exist—would soon starve to death.

Thus it is most appropriate that government, both State and Federal, should provide assistance in every reasonable way to this vital industry, not only because of its basic importance to every citizen, but also because of the exceptional hazards of exploration and because of the peculiar economics of producing a "wasting asset" with which the mineral industries must be constantly concerned.

How then can government best assist the mineral industries? Wasn't it Lincoln who first said that government should do those things—perhaps only those things—which the individual and the private organization cannot do so well for themselves. Amongst such things, the making of a state geologic map has long been recognized as one of the best ways in which a state can provide assistance. No private organization would be justified in undertaking to map, geologically, an entire state. Yet every organization can benefit from having a broad geological picture presented on which it can then the more intelligently select its own targets for the detailed investigations which constitute its special capabilities.

At this point it would be well to comment on a fallacy that too often has led some of our earlier state surveys into difficulties, indeed in some cases into an early demise. It is only natural that a layman taxpayer called upon to appropriate funds for the making of a geological map of his state should think that when the map is done, the job is done, and the survey should end. Laymen—especially laymen of a few generations back—were not familiar with the phenomenon and the importance of technological obsolescence, as we recognize it today. For an example, take topographic mapping. Now topographic features, one might assume, should be far less subject to change than are geological features (which are subject to geological interpretation and reinterpretation!). Some of us old-timers have mapped geology on one-degree topographic sheets, and glad we were to have them. But did the topographic survey stop with country-wide coverage on the one-degree base? No, it was improved with the adoption of 30′ topographic sheets; then 15′; and now we are getting $7\frac{1}{2}'$ quadrangles. Scales have gone from $1'' = 4$ miles, to $1'' = \frac{1}{2}$ mile. Each such advance in topography in itself calls for an improved geologic map.

Where do the states stand on this very important task of providing good geologic coverage? According to a recent and still preliminary compilation by Dr. Peter Flawn (1962), State Geologist of Texas, something less than 20 per cent of these United States is covered by geologic maps on scales of one inch to the mile or better. California is bringing out a new state map, as yet only one-third complete, on a scale of 1:250,000 (about 4 miles to the inch). Our previous state map, over twenty years old and long out of print, was on a scale of 1:500,000, so we are able, in this new edition, to provide about four times as much geological detail as twenty years ago—and we do have the detail to provide! At the same time, we have some mapping projects under way at scales of 1,000 and even 400 feet to the inch, chiefly for the purpose of saving man from himself. This is our new program of large-scale urban mapping, designed for those areas where, with increased population density, man grows increasingly unaware of, and yet increasingly subject to geologic hazards; and where, with increasing urbanization, he increasingly threatens to submerge some of our most important mineral resources. Geologic mapping is therefore a never-ending obligation of government.

If the place to draw the line between the province and the responsibilities of private enterprise and those of a state is at times a bit shadowy, we discover at times an equally shadowy zone when we try to delineate the province of the state, vis-a-vis the federal government. In this matter of geological and mineralogical coverage, however, there remains so much to be done, and as yet such an inadequate effort underway to reach highly desirable goals, that there is no problem. Rather than competition, here is an area in which there is abundant room for maximum cooperation. Currently, Kentucky is the envy of all her sister states in that she is embarked on a ten-year program, in cooperation with the U. S. Geological Survey, which will provide her, when the program is complete, with up-to-date geological coverage of the entire state on $7\frac{1}{2}'$ quadrangles.

What other types of assistance should a state survey provide to the mineral industries? Statistics, and lots of them. Yes, the compiling and keeping and publication of mineral statistics—dry and even dreary as the task may sometimes seem—is an important and very worthwhile endeavor, and can best be done by a state agency rather than by private enterprise. In such endeavor, it should never be forgotten that the completion of every succeeding year's data makes the total record that much the more valuable. When a state has—as we have for some mineral commodities—a continuous record for 80 years, plotting of trends and projections is justified, which would be out of the question from incomplete or shorter-term statistics. Nevertheless, 80-year production records would be quite inappropriate on the post-luncheon menu of MSA, so in by-passing this item, I will only mention that whereas California in 1880 produced over $36 million in gold (in 1852 she had produced over $81 million) in 1961 she produced less than $4½ million. Meanwhile borax, virtually unknown to the Fortyniners, has gone from $100,000 in 1880 to almost $50 million today. *Sic transit gloria mundi!* It is with such trends that a State Mineralogist must be concerned, if his survey's efforts of today are properly to benefit the mineral industry of tomorrow.

Of more interest as a dessert item should be this chart (Figure 5) which is intriguing in that it would seem to contravene the law of diminishing returns. Here we have a plot, by 5-year intervals, of new minerals (new not just to the state, but to the world of mineralogy) that have been discovered in California, starting with melonite, partzite, and calaverite in 1857–59. In all, California has provided the type localities for 61 new minerals, 35 of which are still unknown outside the state. It would seem that in over 100 years, discoveries should be diminishing; but not so! The negative influence of World War II is clearly to be seen, but in the last quinquennium, we have recorded the greatest number of discoveries yet, and I have left a question mark at the top of this column, for the end of the year is not here; nor indeed is the end of new discoveries, as I know just from work now going on in our own and collaborating laboratories. The list (Table 1) from which Fig. 5 was constructed, principally from data compiled by Murdoch and Webb (1956, 1960), will likewise be of interest. In it you will recognize names of many men who have made mining and mineralogical history, including four past presidents of our Society: Kraus, Merwin, Foshag and Tunell.

Until recently the most extensive and most ambitious use of mineral statistics was to be found in the so-called Paley report (Paley, 1952), with which you must all be familiar. And perhaps you are familiar too, with some of the analyses made a decade later of the projections of the Paley report, which showed that on the whole, the projectionists had a

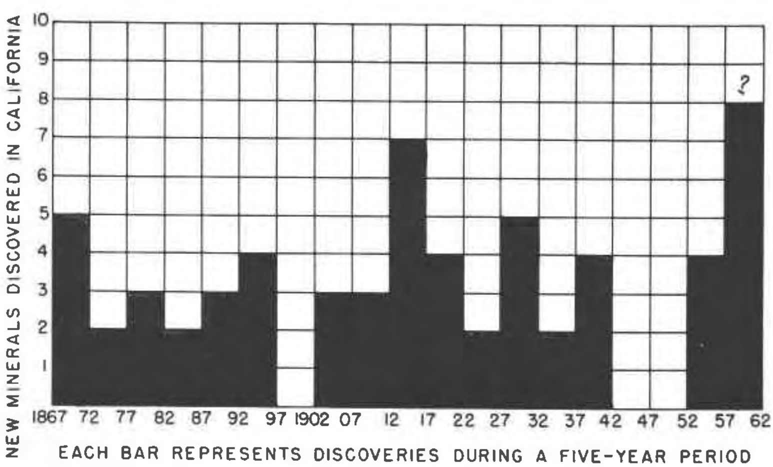


FIG. 5. New minerals discovered in California, 1867–1962.

TABLE 1. MINERALS FIRST FOUND IN CALIFORNIA

MELONITE 1867	*TYCHITE 1905	SANBORNITE 1931
*PARTZITE 1867	*BENITOITE 1907	*SCHAIRERITE 1931
CALAVERITE 1868	*ARCANITE 1908	TILLEYITE 1933
*MARIPOSITE 1868	*JOAQUINITE 1909	*BURKEITE 1935
METACINNABAR 1870	*SALMONSITE 1912	*ELLESTADITE 1937
*STIBIOLERITE 1873	SICKLERITE 1912	*WOODEHOUSITE 1937
ROSCOELITE 1875	STEWARTITE 1912	*TEEPLEITE 1938
POSEPNYTE 1877	INYOITE 1914	*VEATCHITE 1938
*IONITE 1878	*MEYERHOFFERITE 1914	*SAHAMALITE 1954
TINCALCONITE 1878	SEARLESITE 1914	*GALEITE 1955
COLEMANITE 1883	WILKEITE 1914	*GERSTLEYITE 1956
*HANKSITE 1884	*GRIFFITHITE 1917	*NEKOITE 1956
NAPALITE 1888	HIBSCHITE 1920	*GOWERITE 1959
SULFOHALITE 1888	VONSENITE 1920	*HAIWEEITE 1959
*REDINGTONITE 1890	MERWINITE 1921	*METAHAIWEEITE 1959
IDDINGSITE 1893	*KEMPITE 1924	*SCHUETTEITE 1959
LAWSONITE 1895	FOSHAGITE 1925	*NOBLEITE 1961
NORTHUPITE 1895	*KERNITE 1927	*REDLEDGEITE 1961
PIRSSONITE 1896	*PROBERTITE 1929	*TUNELLITE 1961
*BAKERITE 1903	KRAUSITE 1931	*WIGHTMANITE 1962
BOOTHITE 1903		

* Indicates known only from California.

pretty good batting average. Very recently, Resources for the Future published a veritable mine of interesting statistics in the volume by Potter and Christy (1962) on "Trends in Natural Resource Commodities." Since many of you may not yet have had an opportunity to review this volume, I am reproducing a few charts from it which are pertinent to this discussion.

Figure 6 shows per capita consumption in various resource sectors. This chart (Potter and Christy, 1962, p. 9) reinforces what I said earlier concerning the increasing importance of minerals. Note that throughout this nearly 90-year record for the United States, minerals have shown the sharpest increases, and that although the slope (rate of increase) for minerals decreases from $4\frac{1}{2}$ per cent (1870–1910) to $1\frac{1}{2}$ per cent subsequent to 1910, it is still significantly greater than all resources combined, and greater than any other single resource. To put it differently, we might say that while our appetite for groceries is tapering off (and a good thing this is for our generally overweight Americans!), our appetite for the products of the mineral kingdom continues unsatiated.

Figure 7 (Potter and Christy, 1962, p. 12) provides a different and very important perspective on minerals. Note in the upper curve the increasing importance of minerals relative to manufacturing up to about 1912, and the relatively steep decline since. And note in the lower curve

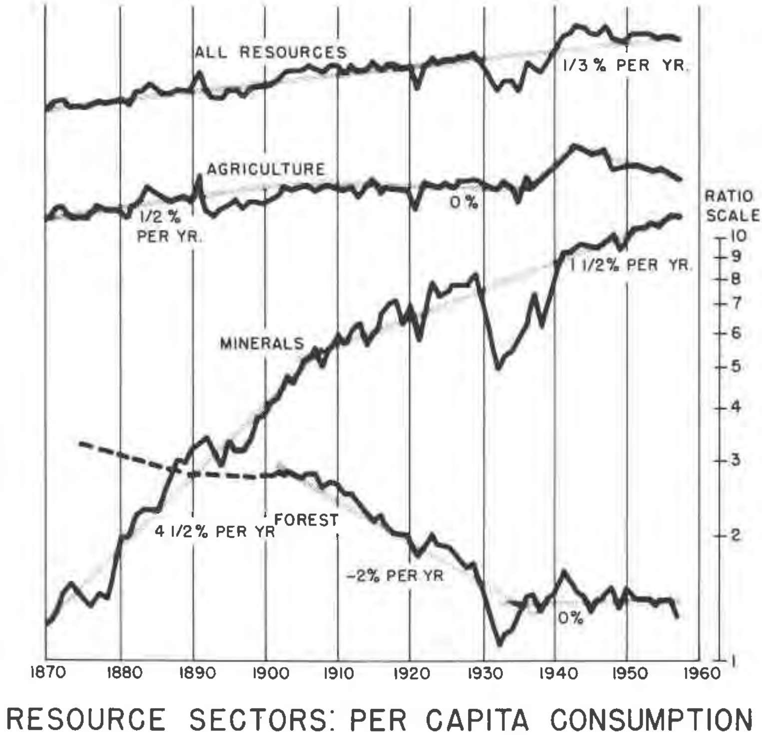

ALL RESOURCES
1/3 % PER YR.
AGRICULTURE
1/2 %
PER YR.
0 %
RATIO
SCALE
10
9
8
7
6
5
4
3
2
1
1 1/2% PER YR.
MINERALS
4 1/2% PER YR
FOREST
-2% PER YR
0%
1870
1880
1890
1900
1910
1920
1930
1940
1950
1960
RESOURCE SECTORS: PER CAPITA CONSUMPTION

Fig. 6.

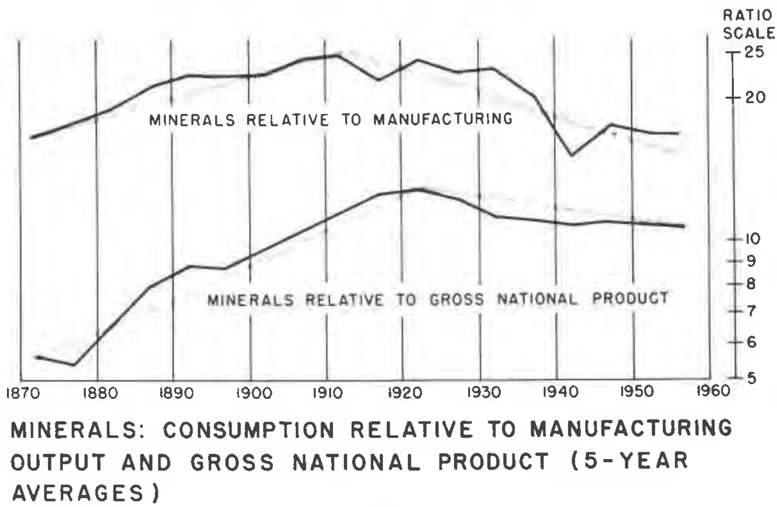
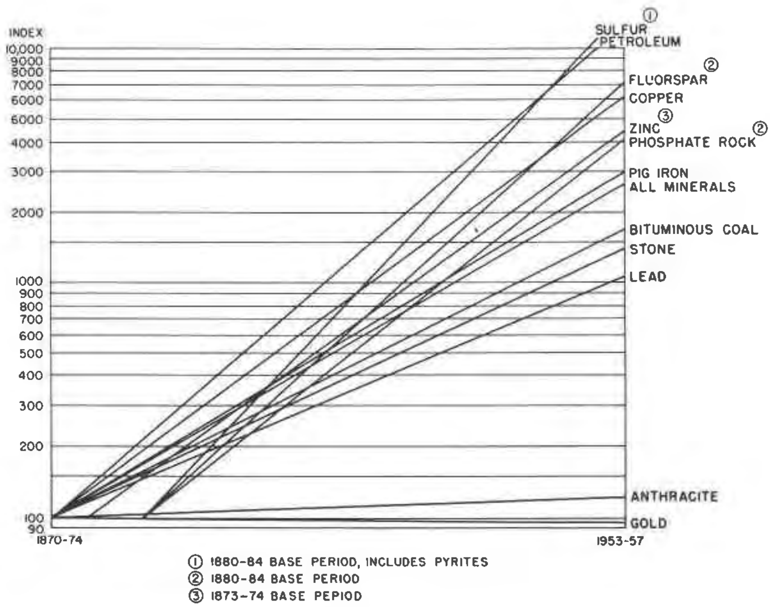

RATIO
SCALE
25
20
10
9
8
7
6
5
MINERALS RELATIVE TO MANUFACTURING
MINERALS RELATIVE TO GROSS NATIONAL PRODUCT
1870
1880
1890
1900
1910
1920
1930
1940
1950
1960
MINERALS: CONSUMPTION RELATIVE TO MANUFACTURING OUTPUT AND GROSS NATIONAL PRODUCT (5-YEAR AVERAGES)

Fig. 7.



MINERALS: GROWTH IN OUTPUT, 1870-1957

Fig. 8.

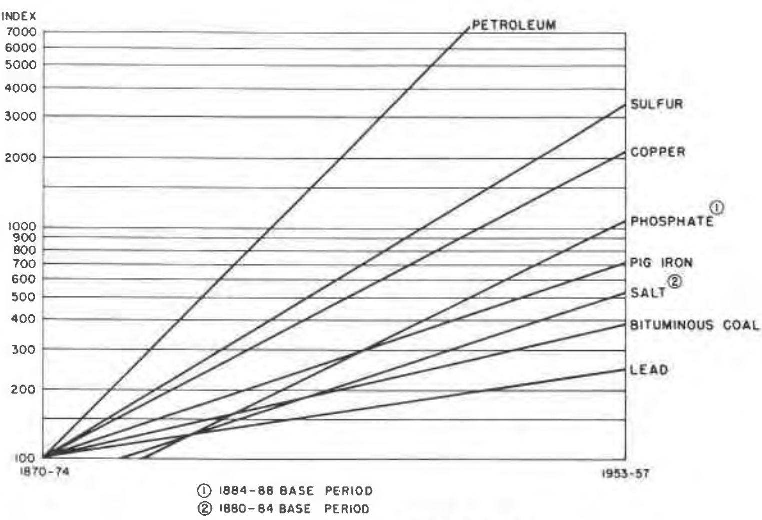
that from the 1870's on, the importance of minerals relative to the Gross National Product rises even more steeply than is the case in relation to manufacturing, and that the curve continues to rise until 1922. Since 1922 there has been a decline, but less steep than in the case of minerals relative to manufacturing. No doubt this is in part owing to the increasing importance of such minerals as sand and gravel which bulk large in the GNP but do not enter significantly into manufacturing.

Figure 8 (Potter and Christy, 1962, p. 7) is in part a reflection of the preceding, but in addition the chart indicates actual growth in selected areas of the mineral industries. Note the mineral products (Fe, Zn, Cu, F, S, etc.) whose curve lies above the general average for all minerals, versus those that are lower; and note in particular the almost level lines for anthracite and gold.

There is much food for thought in even this small sampling of charts based on laboriously compiled statistical data. We see that there are different ways of looking at minerals relative to our economy, and it is important that we realize this. For example, recognizing that minerals are a declining percentage of our GNP, need this be a matter of great concern? Not if we recognize, first, that this is *relative* to a Gross National Product which itself is increasing and which reflects our widening interests in and demands for a greater variety of goods and materials; and, second, that *absolute* consumption of minerals is continuing to rise, as is per capita consumption (See Figure 9, taken from Potter and Christy, 1962, p. 11).

Many in the educational field have bemoaned the decline in college enrollment in the mineral sciences. Yet we might deduce from these charts that this is in part a relative matter—it is a decline that is relative to other disciplines that reflect the widening demands of today's civilization (evidenced also by our increasing GNP). To this extent we need not bemoan the changes in college enrollments. To the extent, though, that mineral science enrollment involves an absolute decline, we do have cause for serious concern.

This brings me to another area in which State and Federal Geological and Mineralogical surveys should cooperate in developing an effective role—*viz.*, in smoothing out the economic cycle of employment which in the mineral industries is wont to fluctuate through a wider range than in most other sectors of our economy. And such fluctuations in professional employment are immediately reflected in student enrollment and choice of major. Too often we think the only effective role of government in anticipating or alleviating recession, lies in promoting "public works"; *i.e.*, lay more highways, construct more dams, build more pyramids. Desirable as these may be, is it not equally desirable that in doing these things we should lay our highways on better ground, freer from landslides; that we should put safer dams on better damsites; and that we should build our pyramids of better constructional materials? But in order to do



MINERALS: PER CAPITA CONSUMPTION

FIG. 9.

this, we must have more men, with better training in the mineral sciences. Assure students of a challenging and a rewarding job when they are ready to enter their professions, and the enrollment will take care of itself. Deny such opportunities, and the supply of future professionals and scientists will dwindle, if not die. Specifically, it should be a goal of State and Federal Surveys alike to create more professional jobs when recession forces cutbacks in industry. To be sure, when industry is on the rise again, it will hire away from us some of the more able and the less dedicated of these public servants; but in the meantime both the public and the profession will have gained from their services, and industry itself will greatly profit from the added knowledge and wider experience these men will have obtained. The agencies which have employed them can feel happy—or at least gain cold comfort—from having contributed to that training and experience.

Additional areas in which geological and mineralogical surveys can contribute are many: reference libraries, core repositories, mineral displays, map files, identification laboratories, and of course and above all the whole field of basic and applied research which is still far from being overcultivated—especially in the mineral industries. But I will take time to discuss only one more, because it is so often overlooked, *viz.*, the field of public education (perhaps I should better say, education of the public). In my opinion there are few fields and few disciplines which better serve to keep man's feet on the ground, than mineralogy. Youngsters and oldsters alike are attracted to minerals, and through this attraction education can be continued, as self-education rightfully should be continued, from whatever point mere schooling ended, right on through all the adult years. In this, state geological and mineralogical surveys have an especial opportunity in that currently they operate in 46 of the 50 states, and can thus reach the public more readily than any private or other public agency. Furthermore, it could be pointed out that it is to our own enlightened self-interest to see that the public is fully informed of the values to be obtained from education in the field of minerals.

Educated for what, and in what? In where to look for minerals; in how to recognize minerals; in what the importance of a mineral is? Yes—all these and much more: knowledge of conservation and of basic economics can come from studying minerals too; and almost inevitably one will learn something of physics and chemistry, and even history, if he will but follow the ramifications of mineral science. Most important of all, I feel, is the education that study of minerals can provide in "the scientific method." This teaches us to discount the superficial and seek the fundamental, just as we discount the color of a mineral and test its hardness. This teaches us to seek all the facts before coming to a conclusion, as for example when we test for hardness and streak and specific gravity and index before attempting to name an unknown. Geology, perhaps more than mineralogy, can also teach us that important decisions must sometimes be made on limited evidence; and it teaches us the value of different approaches and of multiple working hypotheses.

All this is part of the "scientific method"—basically, it is an approach that teaches honesty and objectivity. Certainly I need not belabor this point before this audience. What needs to be belabored is the seeming woeful lack of these qualities and these attitudes in much of the public. For example, we have just come through an election campaign. Judging by newspaper headlines, voters' decisions were expected to be made on hearsay evidence, on pure emotionalism, on misrepresentation, and on downright ignorance. If out of this electoral process we emerge with able men as our statesmen-politicians, then it is surely more by miracle than by design. How much longer can we afford to depend on miracles? Should we not be doing everything possible to give "Homo Americanus" —if he is to survive—more insight and experience in the scientific method? How better than by encouraging him in the pursuits of mineralogy? Resorting to baseball parlance once again, we have had, in World Wars I and II, two strikes against humanity in this century. World War III almost certainly will mean three strikes, and out. If this happens, I would hope that in another millennium, when colonizers arrive from Mars, they will discover still preserved at least a few well-documented mineral museums in each of the several states. Man could leave behind no finer monuments to the science and to the industry that carried him to the peak of his achievement while, at the same time, providing him with the wherewithal for his own destruction.

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