

THE GEOLOGY OF SOME ZEOLITE DEPOSITS IN THE SOUTHERN WILLAMETTE VALLEY, OREGON*

Wallace D. Kleck
Department of Geology, Washington State University
Pullman, Washington

Introduction

Little work has been done and few descriptions have been published concerning the zeolites of the southern Willamette Valley. Mitchell (1915, p. 50), Zodac (1940), and Roberts (1945) note that some zeolites are found in the stream gravels of the area; Staples (1946, p. 578-579) discusses some of the zeolites from Coburg Butte; Lewis (1950, p. 31) notes zeolites in the vesicles of some of the lavas of the Coburg Hills; Wilson (1954, p. 486) describes some of the zeolites from Springfield Butte.

The general geology of the area, which is discussed by Lewis (1950), Vokes, Snavely and Myers (1951), Schlicker and Dole (1957), and Peck and others (1964) may be briefly described as follows. A series of sandstone, siltstone, and tuffaceous beds of Oligocene age lie under recent alluvium and crop out in the hills along the edge of the southeastern Willamette Valley. Basic dikes and sills intrude, and lava flows cap the sedimentary rocks. The igneous rocks are Oligocene to Miocene in age and typically are basalts, andesites, or dacites. The Willamette River and McKenzie River have broad flood plains over which a considerable amount of recent alluvium has been deposited. Small amounts of zeolites are found in many of the lava flows and plutons.

In this area the zeolites occur in veins and in cavities of various origins. The cavities are seldom completely filled. The zeolites commonly occur as well-formed crystals, and many of the minerals may be recognized by their morphology. Six zeolite deposits were studied in detail by the writer and approximately 15 more were studied in less detail (Kleck, 1960). Four of the six deposits studied in detail were chosen for description in this report (Figure 1).

*The descriptions of the deposits presented in this report are taken from the author's master's thesis completed at the University of Oregon in 1960. Since deposits have not been checked recently, it is probable that the appearance of some has been modified by quarrying or by weathering.

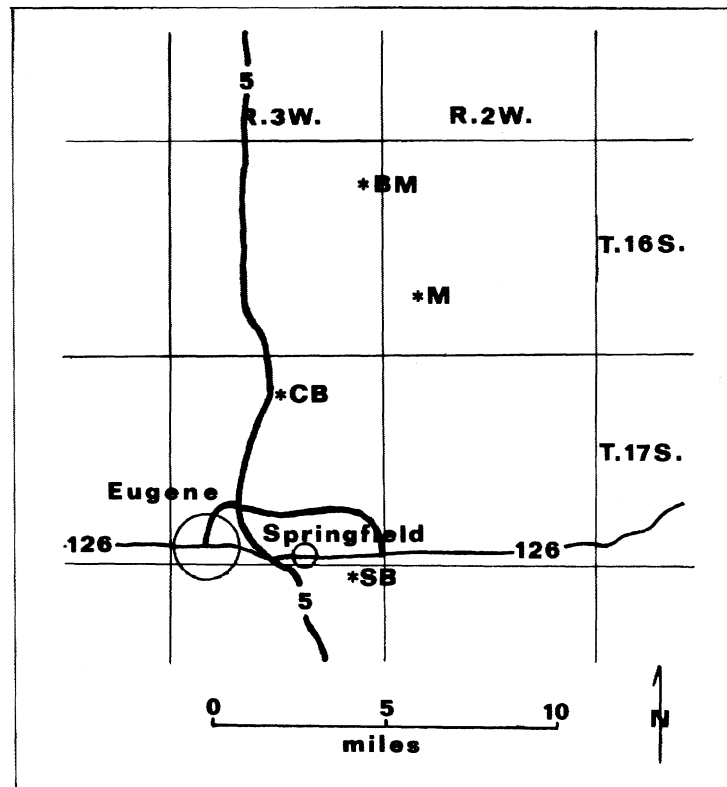


Figure 1. Locality map. BM=Buck Mountain deposit; M=M-120 deposit; CB=Coburg Butte deposit; SB=Springfield Butte deposit.

Description of the Deposits

Buck Mountain deposit

This deposit is in a small quarry located in the SW $\frac{1}{4}$ sec. 12, T. 16 S., R. 3 W. of the Eugene quadrangle. The zeolites occur in a basalt flow approximately 15 m thick. The flow consists of about 75 percent labradorite, 20 percent clinopyroxene and small amounts of magnetite, nontronite, and altered olivine. The lower part of the flow is dark-grey, dense, and contains scattered large vugs (figure 2); the upper part is composed of partly to highly altered, vesicular basalt. The estimated zeolite content of the flow ranges from about 1 percent in the lower, dense part to about 30 percent in the upper, altered part. In the lower part of the flow the zeolites are confined to fractures and vugs; in the upper part zeolites replace some of the minerals in the rock as well as fill fractures and vesicles (Figure 3). The zeolites and associated minerals in order of abundance are thomsonite,

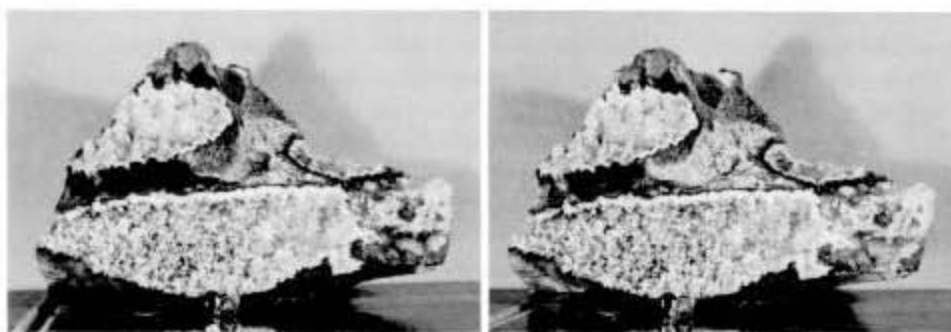


Figure 2. Stereo-pair of gas-formed vugs in the dense part of the flow at Buck Mountain. The specimen contains nontronite, stilbite, and calcite.



Figure 3. Fractures and vesicles filled with zeolites in red, altered basalt. Mesolite comprises approximately 30 percent of this rock.

mesolite, calcite, chabazite, stilbite, heulandite (note: heulandite is not distinguished from clinoptilolite in this paper), nontronite. Analcime is uncommon. Thomsonite and mesolite predominate in the upper part of the flow; chabazite, stilbite, and heulandite predominate in the base of the flow. These two assemblages grade into one another in the center of the flow.

M-120 deposit

This deposit is located in a road cut in the NE $\frac{1}{4}$ sec. 32, T. 16 S., R. 2 W. of the Eugene quadrangle. The zeolites occur in a basalt flow which at minimum is 8 m thick. The basalt consists of about 75 percent labradorite, 20 percent clinopyroxene, 5 percent magnetite, and small amounts of nontronite and altered olivine. The upper 3 m of the flow is vesicular, altered, and purplish-grey; this is gradational with about 2 m of grey, dense basalt. Zeolites compose about 10 percent of the flow and occur in vesicles, vugs, and fractures. Cavities which are not intersected by fractures are not mineralized. The secondary minerals in order of abundance are thomsonite, mesolite, analcime, chabazite, calcite, nontronite. Heulandite, stilbite, and copper are uncommon. Thomsonite and mesolite are by far the most common zeolites in the upper part of the flow; chabazite and analcime predominate in the lower part.

Coburg Butte deposit

This occurrence of zeolites is located in a road cut on U.S. Highway 99E about 100 m north of the McKenzie River Bridge. The zeolites occur in a basalt porphyry which intrudes the Eugene Formation. The basalt has large phenocrysts of plagioclase and contains about 70 percent bytownite, 20 percent clinopyroxene, 5 percent nontronite, and 2 percent magnetite. Thomsonite was observed to replace some of the plagioclase near the edges of fractures (Figure 4). The zeolites occur within the pluton in a faulted and brecciated zone (Figure 5) about 8 m wide. They compose about 2 percent of this zone. The zeolites and associated minerals in order of abundance are analcime, nontronite, thomsonite, calcite. Natrolite, stilbite, laumontite, and pyrite are uncommon.

Springfield Butte deposit

This deposit is located in a quarry in the NE $\frac{1}{4}$ sec. 1, T. 18 S., R. 3 W. of the Marcola quadrangle. The zeolites occur within a fine-grained basalt pluton which intrudes gently dipping lava flows. The basalt contains about 75 percent labradorite, 20 percent clinopyroxene, and small amounts of magnetite and nontronite. The zeolites occur in a "U"-shaped area of altered and brecciated rock. They have been deposited in fractures and large fracture-formed cavities (Figure 6). Zeolites compose about 20 percent of

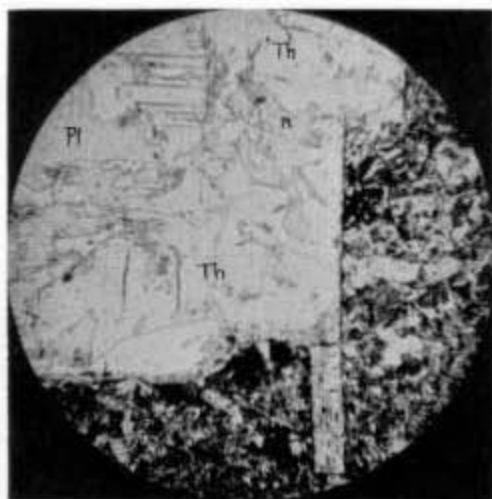


Figure 4. Photomicrograph of thompsonite (Th) replacing plagioclase (pl). Approximately 30 percent of the plagioclase remains. Plain light, X34.

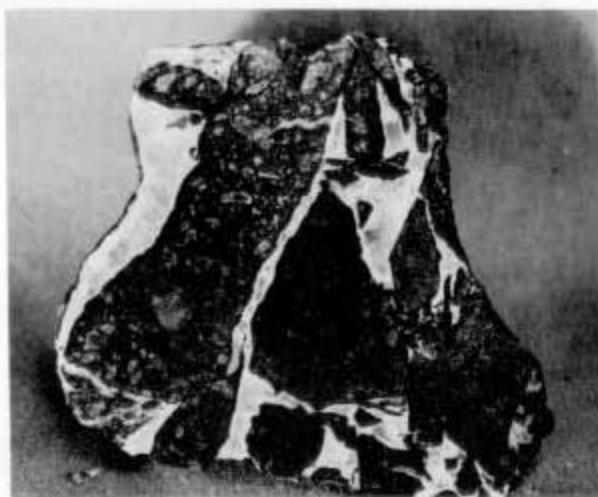


Figure 5. A cut section of rock from the brecciated zone at Coburg Butte showing cementation by thompsonite and analcime. X0.7

the rock. In places, up to 50 percent of the primary minerals in the rock may be replaced by zeolites, nontronite, or other secondary minerals. The secondary minerals in order of abundance are natrolite, chabazite, heulandite, nontronite, analcime, calcite, mordenite. Gmelinite, copper, thomsonite, and phillipsite are uncommon. The deposit is zoned, grading from an area dominated by natrolite to one in which chabazite is the dominant zeolite.

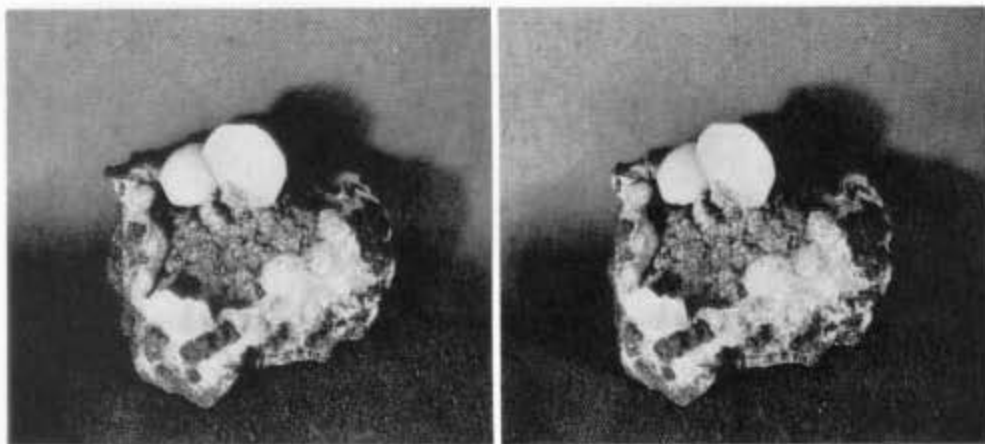


Figure 6. Stereo-pair of chabazite (phacolite habit) on heulandite from a fracture-formed vug. $\times 0.7$

Genesis of the Zeolites

Hydrothermal fluids may have supplied some of the elements and some of the water necessary for the formation of the zeolites. However, the largest amount of the elements were probably derived from the host rock. This is suggested by two observations: (1) the host rock has been altered where the zeolites are deposited; (2) a definite correlation exists between the amount of alteration of the host rock and the amount of zeolites deposited, i.e., the greater the amount of alteration, the greater the amount of zeolites.

The deposits of zeolites in the intrusive rocks (Coburg Butte and Springfield Butte deposits) appear to have followed this sequence of events: (1) emplacement and solidification of the pluton; (2) faulting and/or brecciation; (3) entry of hot fluids (magmatic or magmatic and meteoric water); (4) alteration of the host rock and deposition of the zeolites.

The sequence and place of deposition of the zeolites within the two lava flows (Buck Mountain and M-120 deposits) indicate a different origin than has been yet suggested. The zeolites (except analcime) deposited at

higher temperatures should contain less water than those deposited at low temperature (Coombs and others, 1959). The paragenetic sequence in the lava flows indicates that the zeolites were deposited with falling temperature. The predominance of higher temperature zeolites (low water content) in the upper part and lower temperature zeolites in the base of the flows is characteristic. These observations strongly indicate that the overlying lava flow is the source of heat.

The sequence of formation of this type of zeolite deposit might be: (1) solidification of a lava flow, (2) fracturing and jointing during cooling, (3) weathering[?], (4) heat (and magmatic fluids[?]) plus meteoric water to alter the older flow and result in the deposition of the zeolites.

Acknowledgments

The writer wishes to thank Dr. Lloyd W. Staples, University of Oregon, for his assistance during the course of this study.

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ZEOLITES IN SEDIMENTARY ROCKS*

During the last two decades, the scientific world has witnessed major research and development efforts on the occurrence and use of natural zeolite minerals and their synthetic molecular-sieve counterparts. Since their discovery in saline-lake deposits of Tertiary age in the western United States and in bedded volcanic tuffs in central and northern Japan in the 1950s, more than a thousand occurrences of zeolites have been discovered in sedimentary deposits throughout the world.

Previously known only as well-formed crystals in vugs and cavities of basalts and other traprock formations, zeolites are now recognized as major constituents in numerous bedded pyroclastics, and are accepted today as some of the most widespread and abundant authigenic silicate minerals in sedimentary rocks. Zeolites have found important applications in many phases of technology and are of particular value in the fields of drying, ion-exchange, gas separation, and catalysis, as well as other applications that take advantage of their low mining cost, such as for fillers in the paper industry, as soil conditioners, in animal husbandry, in pozzolanic cements, and as acid-resistant adsorbents in gas drying.

To foster closer cooperation between scientists of the two leading countries in the field of sedimentary zeolites, a seminar on the "Occurrence and Mineralogy of Sedimentary Zeolites in the Circum-Pacific Region" was held last July 19-24 in Nikko and Kaminoyama, Japan. The seminar was attended by 8 geological scientists from the United States, 16 from Japan, and 1 representative from the Soviet Union, and was sponsored by the U.S.-Japan Cooperative Science Program with the cooperation of the National Science Foundation and the Japan Society for the Promotion of Science. The seminar successfully combined formal papers on the occurrence, mineralogy, crystal chemistry, areal distribution, and industrial use of zeolites with informal field trips to important zeolite deposits, and permitted on-the-site examinations in the presence of a geologist or mineralogist who had studied the deposit in detail.

The history of research and early interest in sedimentary zeolites in Japan and in the United States was discussed at the opening of the seminar by M. Koizumi (University of Osaka) and one of the authors of this report

*Excerpts from: "Zeolites," by Frederick A. Mumpton, State Univ. College, Brockport, N.Y., and Richard A. Sheppard, U.S. Geol. Survey, Denver, Colo. Reprinted by permission of Geotimes, v. 17, no. 3, p. 16-17, 1972.

(Mumpton), the seminar coordinators. They emphasized that although a few scattered occurrences of zeolites in sedimentary rocks were known as early as the 1920s, it was not until a commercial interest in these materials had developed in the 1950s that the full significance of these discoveries became apparent. At present, zeolite occurrences have been recognized in all ages of sedimentary rocks of pyroclastic origin from late Paleozoic to recent, and active research programs are now underway on these materials not only in Japan, the United States and the Soviet Union, but also in Bulgaria, Italy, Yugoslavia, Argentina, New Zealand, Australia, Hungary, France and Great Britain.

The widespread occurrence of the six most common zeolites in altered tuffs of the United States--clinoptilolite, mordenite, erionite, chabazite, phillipsite, and analcime--was outlined by the junior author of this report (Sheppard), who suggested that most of these occurrences are the result of vitric volcanic materials reacting with either meteoric or connate waters of saline, alkaline lakes. In general, the zeolites seem to have formed from volcanic ash by solution-precipitation mechanisms; however, analcime in these deposits occurs only as an alteration product of pre-existing zeolites. In many areas, potassium feldspar is the end product of the alteration process.

The extensive use of natural zeolites in industrial and agricultural applications was outlined by H. Minato, who said that about 5,000-6,000 tons of clinoptilolite and mordenite are mined each month from eight open-pit deposits in Japan. The deposit at Itaya is the largest of these and produces more than 4,000 tons of zeolite per month. In Japan, refined zeolite products are used as inexpensive dessicants, as deodorizing agents in agricultural operations, as soft white filters in paper, as soil conditioners where their large ion-exchange capacities are used, as dietary supplements for chickens and swine, and in the production of oxygen- and nitrogen-gas products from air. This latter use was discussed in detail by T. Tamura (University of Tokyo), who has developed an oxygen-purification process based on the preferential adsorption of nitrogen from air by dehydrated mordenite. The process is used commercially to produce >90 percent oxygen for use in pig-iron smelting operations. A paper was read for R. Sersale (University of Naples, Italy) in which was described the use of phillipsite- and chabazite-rich tuffs from Italian volcanic areas in pozzolanic cements. Sersale has also been able to transform typical vitric tuffs into zeolitic products by treatment in 1 percent KOH solutions at 235°C and 30 kg/cm² pressure.

The current and potential uses of zeolites from sedimentary deposits in the United States were discussed by Leonard B. Sand (Worcester Polytechnic Institute). He reported that in addition to small amounts of mordenite and chabazite-erionite used as drying agents for acid gases, and clinoptilolite for radioactive-waste disposal, mordenite may be suitable for the removal of SO₂ in several pollution-abatement applications.

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NEEDLE ROCK

Len Ramp



A. Needle Rock seen from Crater Lake Highway.



B. Close-up view of the 30-inch "eye."

Needle Rock is a prominent landmark rising 400 feet above Crater Lake Highway (Oregon 62) about 7 miles west of Prospect in Jackson County. The feature is named for a tiny window near the top of the rock. From a distance this hole, which is 30 inches across, looks as small as the eye of a needle. It is visible to highway travelers approaching the rock from either direction.

The top of Needle Rock is a remnant of the rubbly portion of a Miocene lava flow composed of angular basalt fragments ranging from pea size to a foot in diameter. Natural processes of weathering and erosion (wind, rain, freezing, thawing, and gravity) have reduced the top of the outcrop to a narrow ridge only 2 to 15 feet wide. The "eye" is in the thinnest part, about 6 feet below the ridge top, where loosened rubble has gradually fallen out. Another hole, as yet only about 6 inches across, is developing a few feet away. It will probably enlarge, just as did the bigger one, when more basalt fragments weather loose and drop out. These holes represent erosional caprices of nature and will eventually disappear as the top of Needle Rock is slowly worn away.

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MARKETS AND RECYCLING - CONFLICTS IN PUBLIC POLICY*

Fred Berman, President
Institute of Scrap Iron and Steel

Although the concept of recycling is not new, I believe we would all agree that the popularity of this concept has now firmly entrenched itself in the United States. It is probably fair to say that popularity, as far as the general public is concerned, is beginning to give way to the realization that reclamation of our discards is an absolute must.

Those concerned with the quality of our environment, from a decision-making point of view, readily acknowledge the validity of reclamation as the objective in reducing land pollution.

Yet, at this point in time, there exist basic conflicts in public policy which place an unworkable burden on those engaged in the day-to-day business of converting discards into a form which can be used as a raw material for making new products.

The iron and steel scrap processing industry dates back to the 1800's in the United States. It was in 1928 that the Institute of Scrap Iron and Steel was formed. The 1300 member firms which make up the Institute today are actively involved in taking iron and steel discards - the effluents of our affluence - and processing them into grades of scrap for remelting into new products by steel mills and foundries.

With scrap processing plants located throughout the country, representing tremendous investments in equipment and expertise in the processing of metals, you may wonder why General Motors estimates there are 800,000 automobiles abandoned annually despoiling the countryside. This is in addition to those stockpiled in auto wreckers' yards and auto graveyards. Not to be overlooked are the untold numbers of abandoned refrigerators, stoves, washing machines, farm machinery and the like. It is estimated that the obsolete automobiles alone represent more than \$1 billion worth of reusable metal which is not being recycled.

And what about the steel cans and other small forms of metallics which find their way into each home's trash can - the can that generates a total of nearly one ton of household waste per person per year? Our ability to generate waste is rapidly increasing. A recent survey by the Department of Health, Education and Welfare indicates that by the end of the century the one ton figure will almost double. These somewhat frightening statistics emphasize the validity of the recycling objective. Why then, in the case of iron and steel, do we find accumulations of metallic solid waste?

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Collection is not Recycling

The basic answer to that question comes in the form of one word - markets. Without markets for the processed commodity, there is no recycling. The act of waste being collected in one or a group of locations cannot be construed as recycling. The act of converting metallic solid waste into a grade of scrap which remains in the scrap processor's plant cannot be construed as recycling. Nothing is recycled until it is used as a raw material to make a new product which is then sold in final form in the marketplace. The scrap recycled would conserve a limited natural resource, namely iron ore.

For the concept of recycling to function properly, a closed cycle is required. The reason we are faced with continuing accumulations of metallic solid waste is that there exists a rather large gap in the cycle - the link between the scrap processor and the steel mill and foundry is not as strong as it should be. Running the cycle in reverse order, if steel mills and foundries choose not to use the available iron and steel scrap as a raw material, the scrap processor will obviously reduce his production capabilities. This means the scrap processor will reduce the amount of unprepared iron and steel that he buys; which means that if this material does not move to the scrap processor, it will go to landfills, dumps or accumulate in the cities and countryside.

This was the problem facing the iron and steel scrap processor throughout 1971 and the prognosis for 1972 appears none too bright at this time. To be sure, scrap is moving, but not in the tonnages which it can and should be moving.

The price for the material is also depressed. With deflated tonnages and prices, the obsolescent grades of scrap - those grades which originate from metallic solid waste - are the hardest hit. They are the discards which, in the absence of strong markets for processed scrap, accumulate and deface the landscape.

There are two factors which hinder the marketability of iron and steel scrap - two conflicts in public policy which I cited previously.

Freight Rate Discrimination

The first is freight rates to haul scrap which are about $2\frac{1}{2}$ times higher than the rates for virgin iron ore, an irreplaceable natural resource. The Interstate Commerce Commission, a regulatory agency established by the Federal government, refuses to acknowledge the fact that scrap and iron ore compete as raw material inputs in steelmaking. We find this incredible and defying all logic. World renowned metallurgists have testified before the Commission that scrap and ore do compete and no one has ever refuted this testimony.

A recent study conducted for the Institute documents that this discrimination in freight rates presently results in a \$4.21 higher cost than necessary to produce a ton of steel using purchased-scrap as the raw material. The freight rate alone pushes the recycled material to a tremendous disadvantage.

The second factor is the 15 percent ore depletion allowance - an incentive which the Institute does not oppose. There seems to be good reason for this tax advantage. However, the concept begs the statement - some form of tax incentive should also be provided to the secondary product in order for it to compete with the virgin material. Denying the tax incentive to the secondary material is to provide a major advantage to the virgin product and to hinder the use of otherwise desirable scrap materials.

Let there be no misunderstanding - the scrap industry is not seeking a subsidy from any level of government. If there is to be an incentive to consume, and we believe there should be, the logical recipient would be the consumers, such as steel mills, or if necessary, the railroads. There is no need to subsidize the scrap industry to produce, but there is need to stimulate other industries to consume.

Competing Resources

The point is, scrap should certainly be allowed to compete fairly and equitably with virgin iron ore. If we desire to reclaim our wastes, conserve our natural resources and beautify the landscape, we must stimulate the melting of scrap.

The importance of these market factors, unfortunately, is not generally appreciated. Because local governments throughout the country are faced with mounting problems of solid waste, they are investigating and looking to the concept of recycling as the solution to their community problem. Most of their attention is directed to the establishment of recycling centers as a total systems solution.

As you may be aware, this technique involves the handling of refuse or solid waste which has been collected under local government control and brought to a central point for either disposal or transfer to its final disposal area. Resources are to be recovered from the wastes, so that the volume of wastes which have no value can be reduced, and income would be derived from the sale of the recycled materials.

However, this is a supply based concept. The recycling center, as it is referred to, does not recycle. It merely increases the supply of waste that is available for recycling. The concept is based on pulling materials from refuse that would normally go to the dump or landfill site for final disposal.

But, is the problem we are confronted with a need for more materials for potential recycling - more supply? It has been suggested that the sale of the reclaimed materials from such recycling centers would not only cover the cost of the facility, but could also result in a profit for the program operation. We have yet to be shown just one facility at any location in the entire country able to meet this test or even come close to it.

If the recycling center is only a generator of supply, is the concept economically sound? Are there markets for the reclaimed materials within the area which the recycling center complex will serve? Of what value is an increased supply, if markets do not now exist for the materials already being processed by the scrap processing industry? To make an increased supply a viable solution there must be an increased demand.

Economic Incentives

The expansion of recycling within this country must be parallel to and in conjunction with the development of markets which can absorb the recovered materials. Although the technology exists, the economic incentives do not at this point in time.

In a recent interview Mr. Samuel Hale, Jr., Deputy Assistant Administrator of the Environmental Protection Agency's Office of Solid Waste Management Programs, responded this way to a question concerning public funds versus private enterprise in the area of recycling. He said that private industry would be allowed "to do those things which it can do best, particularly those things where the profit motive is going to lead them in the right direction." He added, "I don't see us getting into the business of establishing a public secondary materials industry. That simply is not an area in which public energy should be channeled."

Concerning markets for recycled commodities he said, "the answer is not primarily in trying to find ways to get more materials recovered, but building up the markets for recovered materials."

Yet many people are clamoring for such centers, funded with public taxes despite the lack of economic rationale. What will be the feedback and reaction to public officials who urged the establishment of these publicly funded centers when the cost far exceeds the rosy projection?

Depressed Markets

Another point of consideration is what would happen to existing markets if there was suddenly a significant increase in supply? The scrap processor is without sufficient markets now and with depressed prices in the markets that exist - a marked increase in the tonnage available on the market would drive prices for processed scrap down even further. The impact would be most dramatic in the case of the obsolescent grades which are in less demand when the market is depressed. The outcome could well be a more thorough depressing of the entire recycling industry, with stockpiles of increased accumulation of metallics throughout the country.

Ecology and citizen groups who have established collection centers have found that the problem of markets can be most frustrating. In some instances they find no outlet whatsoever; in others their products become mere substitutes in that for one recyclable material to move, another

recyclable material that was already moving is now unable to be sold. In many cases the collection centers find that there is a total absence of markets for the collected material; it can't even be given away. Or they may find that the cost to haul the material to the user is greater than the dollar return for the material.

Again, it is a matter of limited demand and the continuing creation of additional supply, in the name of recycling.

I am sure that the individuals who devote time and energy to setting up such a center, in promoting the concept of people bringing materials to them, in getting trucks, containers, a site and all of the other details involved, encounter a great deal of disappointment when they find there is no market for the materials which they have collected to improve the quality of the environment and conserve natural resources.

The scrap processor understands this source of frustration. He is often faced with the same problem. There is a difference, however, which cannot be overlooked. He has invested hundreds of thousands, and in many cases millions, of dollars in equipment to perform the reclamation of metallic wastes. Why then should government consider it necessary to invest again in the same type of equipment? The capacity to process all of the metallic solid waste generated in this country is on line; it is the absence of sufficient markets which causes the problem to grow. The scrap processing industry can make all available metallic waste a recyclable commodity; but the recycling can only occur if markets are available.

If our objective is to insure that recyclable materials are reclaimed, and the scrap cycle is closed so that materials move in an orderly manner from manufacturer, to user, to discard, to reclamation, to manufacturer again, there simply must be markets. To direct our energies and concern at creating more supply, when the need is clearly more demand for what is now available, is an exercise in futility.

Policy makers must reconcile themselves to the fact that recyclable materials - our manmade resources - must be allowed to compete with natural resources. For the system to function, it must be based on sound economic principles. Such is not the case today.

Certainly our objective is recycling, but our attention must be directed first to the need for more demand, not more supply. When the demand for recyclable materials is stimulated, the supply will be forced to follow, and it will follow in the natural course of events. But there is no need for that supply as long as markets cannot absorb what is already available. When that demand is present, I assure you the scrap processing industry will be able to handle the supply. The key to the lock on recycling is demand, and that is what must come first.

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For a copy of the folder, "Scrap Is Not Junk," write the Institute of Scrap Iron and Steel, 1729 H Street, N.W., Washington, D.C. 20006.

ABANDONED MINING CLAIMS NOW SUBJECT TO CANCELLATION

Failure of a mining claimant to comply substantially with annual assessment requirements is grounds for cancellation of his claim under an amendment to the Code of Federal Regulations appearing in the Federal Register of Sept. 1. The new regulation is based on a 1970 decision of the Supreme Court and applies to all mining claims.

The right of the government to cancel claims for failure to comply with assessment requirements had never been established until the Court's decision in *Hickel v. Oil Shale Corporation*.

The new regulation was published in the Federal Register as "Proposed Rule Making" on July 15, 1971.

American Mining Congress Memorandum, Sept. 6, 1972

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BURNS QUADRANGLE GEOLOGY PUBLISHED

"Geologic Map of the Burns Quadrangle, Oregon," by R. C. Greene, G. W. Walker, and R. E. Corcoran, has been published by the U.S. Geological Survey as Misc. Geologic Investigation Map I-680. It can be purchased for \$1.00 from the Survey's Distribution Section, Federal Center, Denver, Colorado, 80225.

The Burns quadrangle is one of the AMS series at a scale of 1:250,000. It is bounded by lat. 43° and 44° and by long. 118° and 120°. The map is in multicolor and shows the distribution of nearly 60 geologic units ranging in age from Devonian to Holocene. Included are cross sections, a small tectonic map, and descriptions of units. The map area covers the northern half of Harney County and edges of adjacent counties; Harney Basin lies in the center. The region is largely covered by Tertiary and Quaternary volcanic rocks and sediments; a small part of the Suplee Paleozoic-Mesozoic region extends into the northwest corner.

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BLUE MOUNTAIN DRILLING PERMIT ISSUED

The Department of Geology and Mineral Industries issued State Permit No. 64 to Standard Oil Co. of California on September 7, 1972, for a 9000-foot exploratory test drilling in southeastern Oregon. The hole is to be drilled on the 100,000 acre Blue Mountain Federal Unit located near Blue Mountain Pass, SW $\frac{1}{4}$ sec. 34, T. 37 S., R. 41 E., Malheur County, approximately 16 miles north of McDermitt. The U.S. Geological Survey, on August 10, 1972, gave Standard permission to drill.

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