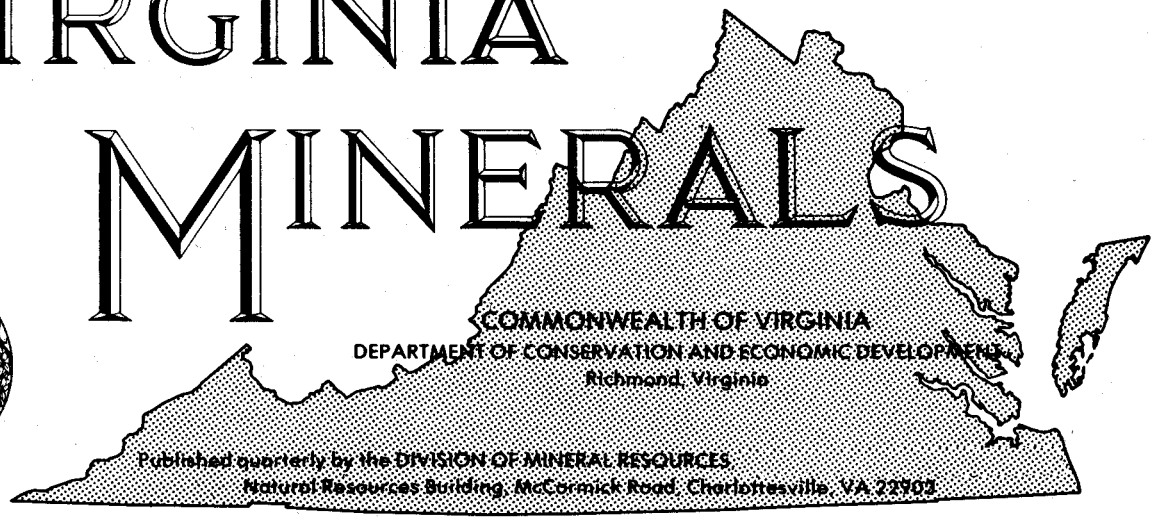
VIRGINIA MINERALS



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MINERALS AND FUELS IN THE 1980's AND 1990's

It is apparent as we enter the final two decades of the 20th Century that the applied geological sciences are experiencing a rebirth. Geologists are needed not only for their classical roles in exploration and production of earth raw materials, but also in the areas of waste disposal, identification of geological hazards, and for land-use planning and development.

The past experience of most of use in this country is one of an expanding economy and generally increasing standard of living, in spite of moderate but persistent population increases. This pattern of growth and expansion was shaken in 1973 by the first Arab oil embargo, when the United States was rudely reminded for the first time since World War II of the dangers of dependence upon foreign suppliers. Since that embargo, and largely because of persistent uncertainties about availability of foreign fuel supplies, the economy has developed exaggerated inflationary tendencies which have not existed since the days following the World War II - Korean War era. It is inevitable that standards of living will decrease as ever increasing world populations apply greater and greater pressures on our finite natural resource base and upon the life support system of the planet.

One of the prime goals of the developed, industrialized world during the remaining decades of this century and in the next century will be the avoidance of an India syndrome. The India syndrome — a large population mass, with most people living at a very low standard of living and with each person allotted only a small share of meagre and ever declining resources — has engulfed much of the world as modern sanitation and medicine have reduced the effects of yesterday's pandemics. The India syndrome can perhaps be avoided by stabilization or, more certainly, by a moderate decline in the world's population — a condition that is not likely to be achieved in the near future.

It is the purpose of this paper to point out some of the problems which our society must consider as it attempts to fulfill its needs for energy and minerals and at the same time to avoid the adverse effects that these activities impose upon the natural environment. In addition, we will attempt to relate the programs of the Division to these problems as it strives to meet the needs of the Commonwealth.

THE NATURAL ENVIRONMENT
THE LIFE SUPPORT SYSTEM

The life support system of the planet is built upon an extremely intricate interrelationship of organisms, plants and animals, with their natural physical and

chemical surroundings — light, heat, soil, water nutrients, etc. On a worldwide basis the composition of the planet's surface, the mother earth and its atmosphere, has changed slowly over a time span measured in hundreds of millions, even billions, of years. Since the creation of the organic world, life forms have generally increased in complexity as they were preferentially selected by long-term changes in the natural environment. This diversity insures continuity of life on the planet, because as some forms become troubled and then extinct during the evolutionary process, others are there to occupy abandoned ecological niches.

During periods of natural disasters, some local, others worldwide, the existing biota does not have time to evolve, resulting in either local or worldwide extinctions and a temporary decrease in diversity of life forms. Natural disasters, such as earthquakes, local changes of sea level and volcanic explosions are common in our life times and cause local "kills" of life. Worldwide climatic changes, such as those during the recent ice ages, resulted in widespread extinctions which are well documented in the geologic past.

In many ways man is a natural catastrophic disaster whose activities cause numerous extinctions both on a local and on a worldwide basis. His adverse activities have generally resulted in a worldwide decrease of biotic diversity; i.e., in a general homogenization of life on earth.

DESTRUCTION OF LAND

The continuing increase in man's population, with concurrent industrialization, is placing a tremendous strain upon the life support system of this planet. Urban and suburban sprawl are removing millions of acres of land from productivity for the foreseeable future, creating man-made deserts populated only by people, dogs, cats, rats and pigeons. In contrast, mining only temporarily decreases biologic productivity, until mined sites are reclaimed by nature with or without man's help.

WASTE DISPOSAL

Today's modern societies have severe problems regarding the handling and disposal of wastes, both municipal and industrial. The difficulty in obtaining suitable landfill sites plagues many American communities. Burial of wastes must be accomplished both with a minimum of esthetic impact upon local communities and with a minimum of damage to the shallow geologic environment, particularly with regard to the escape of leachate into nearby ground and surface waters. The disposal of industrial wastes, in particular those which are radioactive, hazardous or highly toxic, is a problem of increasing importance. Recent events have shown that dumping of these substances into rivers or estuaries (James River) or burial of drums of hazardous and toxic materials (Love Canal) can cause long-lived and far reaching damage, threatening the life and health of human populations, as well as those of other species. Furthermore, introduction of liquid wastes into deep geologic strata can cause disruptions, such as local seismic activity, as stress fields in the earth are changed. Almost all of these chemicals or radioactive substances are unnatural or exist naturally in such small quantities that biota has not generally developed tolerant varieties. However, even poisons can be overcome by nature if time permits organisms to develop resistant strains, as some insects have in their fight to survive against pesticides.

FUEL POLLUTION

All fossil fuels produce carbon dioxide and particulate matter upon burning, which, as they accumulate in the atmosphere, may cause long-range climatic changes. Particles tend to scatter sunlight, thereby reducing the energy incident on the earth. In contrast, accumulation of carbon dioxide in the atmosphere may result in a greenhouse effect, thereby increasing surface temperatures and causing the melting of polar ice caps. In addition, nitrogen and sulfur compounds emitted from tall smoke stacks have produced notably acid rains which have a particularly deleterious effect upon the biota in non-carbonate terrain, where acids persist unneutralized in near-surface environments. Automobiles produce noxious emissions which accumulate and linger close to the ground, especially when certain climatic conditions persist over prominent topographic basins. Nuclear power plants do not produce the noxious oxides and acids which result from burning fossil fuels, but instead produce long-lived, hazardous radioactive wastes. The only clean power sources available to us are from the sun, either directly, or indirectly as wind and water power, and from high temperatures in the earth - solar and geothermal - but these by their very nature can be exploited economically only in certain areas. Table 1 summarizes the characteristics of common energy sources.

Table 1. An analysis of existing energy sources.

ENERGY SOURCE	ADVANTAGES	DISADVANTAGES	FUTURE	ACTION REQUIRED
Petroleum	Refined to a variety of liquid and gaseous fuels; petrochemical industry; easily produced, transported, stored.	Air pollutant when burned, contributes nitrous oxides, sulferous oxides, and carbon dioxide to atmosphere; carbon dioxide promotes greenhouse effect.	Increasing demand and costs; declining reserves and production; will become uneconomic as fuel in 21st Century.	[1] Conservation through mass transit, decreased use of automobile; development of tar sands, and oil shales; secondary, tertiary recovery in old oil fields.
Natural Gas	Easily produced, transported and stored, generally clean burning.	Contributes primarily carbon dioxide to atmosphere; promotes greenhouse effect.	Increasing demand, and costs; declining reserves and production; volume produced will progressively decrease in 21st Century.	[1] Development of shale gas; methane from coal beds; improvement of methods of transportation from remote sources.
Coal	Abundant, easily produced, transported and stored.	Air pollutant when burned; contributes nitrous oxides, sulferous oxides, carbon dioxide to atmosphere; carbon dioxide promotes greenhouse effect. Source of acid rain when gasses vented through tall stacks. Temporary impact on mined land.	A primary source of energy during 21st Century, will be converted to liquids, gasses.	[1] Development of liquefaction, gasification plants, improvement of technology for removing wastes from smoke stacks prior to emission.
Hydroelectric	Reliable source of cheap electric power; once installed will generate power for a long period of time with minimum maintenance. Nonpolluting, renewable.	Requires flooding of large areas of prime farmland.	Renewable source of electric energy.	[1] Development of remaining potential high-head reservoirs; development of low-head reservoirs; development of tidal power plants.
Nuclear reactors	Reliable source of cheap electric power; does not contribute to air polution, or greenhouse effect.	Produces long-lived radioactive wastes; possible source of illicit nuclear weapons.	Short-term (25 years) supply of uranium available for fuel.	[1] Development of fool proof methods for storage of wastes; protection of fuel. Improve nuclear-power plant safety.
Geothermal	Reliable, long-lived source for hot water (low temperature geothermal) and/or steam (high temperature geothermal); generally non-polluting.	Site-specific, requiring local geothermal source and water. Fluids produced may be corrosive.	Will be widely developed in suitable areas.	[1] Identification of geothermal sources.
Solar	Reliable, non-polluting, renewable.	Seasonal and geographic restrictions.	Solar power will ultimately replace petroleum, natural gas, and coal for space heating, electrical power generation.	Develop solar technology.
Biomass	Reliable, non-polluting, renewable.	Land currently used for other purposes will be diverted to producing fuel-producing crops. Food grains will be diverted to producing alcohol.	Ultimate source for hydrocarbons to be used as solid, liquid or gaseous fuel.	Identify, develop and grow organisms suitable for fuel or as a source of fuel.

[1]Requires major input from geological sciences.

MINERALS AND FUELS

Mineral resources, including mineral fuels, metallic ores, and non-metallic materials, vary individually in abundance and geographic distribution in the earth's crust. These resources are non-renewable and, although useful deposits may range from small to very large, all of the materials are finite in amount. Because of the unequal distribution of mineral resources throughout the world, nations have varying degrees of self-sufficiency in the materials that they need. Certain countries have been richly endowed by nature whereas others have very limited resources. The United States is fortunate in having adequate quantities of some resources, such as coal, because of both the diversity of its geology and its extensive area, but is dangerously deficient in others.

FOREIGN FUEL DEPENDENCE

During periods of peace and political stability, international trade in mineral commodities provides nations, including our own, with the required mineral raw materials. When normal patterns of supply are interrupted or changed by wars, political unrest, changing national alliances, embargoes, nationalization of production, or other factors, however, the consequences have a profound impact. The United States has become increasingly dependent upon foreign sources for many of its raw materials. One aspect of foreign dependence is being dramatically demonstrated by our reliance upon OPEC nations for much of our oil supply. During the first half of 1979, for example, about 22.5 percent of the energy consumed in the U. S. was supplied by imported oil which was purchased at ever-escalating prices, causing large deficits in our world trade balance.

OIL AND NATURAL GAS

Our nation's attention has been focused in recent months on the current oil shortage and the change in the American lifestyle that will likely be the result. The problems of decreasing domestic reserves and increasing costs for imported petroleum have been made real to the public by long lines at service stations and higher prices for gasoline, heating oil, diesel fuel, jet fuel, and numerous other petroleum-based products. Domestic oil production peaked in 1973 and world crude oil production showed almost no change between 1977 and 1978. This indicates that economic expansion must be based on conservation and wiser use of petroleum as we develop and switch to other energy sources. The petroleum supply in the U. S. from 1930-1977 is shown by Figure 1. Similarly the public is becoming more aware that natural gas is a non-renewable energy source that is ultimately limited in quantity, and that it will be increasingly more expensive to industrial and residential consumers. The confusion and discomfort created by even a brief interruption of electrical service, and the possibility for large-scale "brownouts" in the future, serve to emphasize what may occur if adequate fuel sources for the generation of electric power are not available. The many problems associated with depletion of our oil and gas, and the activity needed to change the country's energy-base to other more-plentiful sources such as coal and solar energy will call for a great national effort in planning, manpower, capital, and materials. The need to make this effort, however, is beyond question.

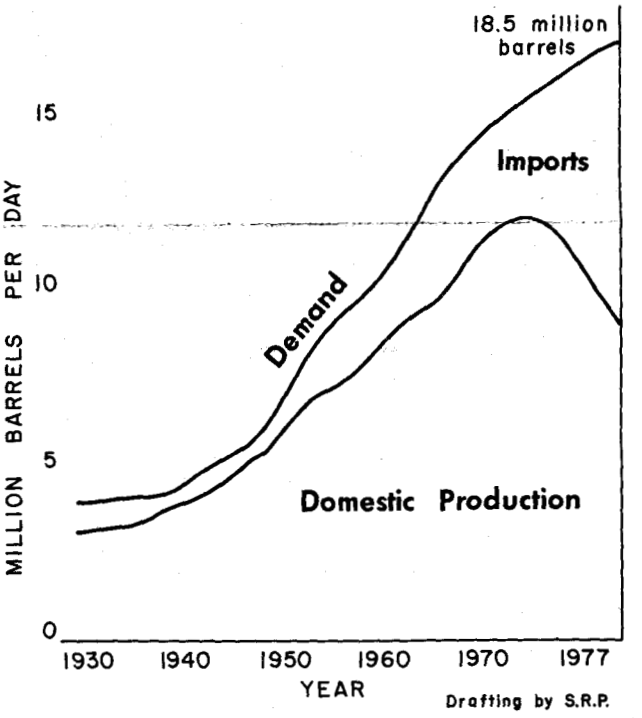


Figure 1. The petroleum supply in the United States from 1930-1977 (Gulf Oil Corporation, 1979).

NONFUEL MINERALS

The public is hardly aware, however, of the less-publicized but equally grave situation that confronts the United States with regard to other mineral supplies. Simply stated, the nation does not have sufficient, known domestic supplies of many nonfuel mineral commodities to meet all of our future needs. The economy and security of the U. S. are based

largely on a wide range of mineral resources, including the energy resources previously discussed. The U. S. Bureau of Mines (1978) reports, for example, that over 21,000 pounds of new nonfuel mineral materials, including metals and nonmetals, are required annually for each American; in 1977 the total use of new nonfuel mineral supplies in this country was about two billion tons. Approximately 100 nonfuel mineral commodities are used for industrial and agricultural purposes. As our population grows, the demand for products and activities based on these mineral supplies will also grow dramatically. If we are to sustain our standard of living and national security the country must be assured of adequate supplies of these materials in the future. Under present conditions there is no such assurance.

FOREIGN MINERAL DEPENDENCE

The United States has large reserves of some resources such as phosphate rock, stone, and sand and gravel. Domestic production of numerous other materials such as iron ore is augmented by imports to meet levels of consumption. Our requirements for still other commodities, some of strategic importance, are entirely or almost entirely dependent upon imports from foreign countries. The U. S. has an uncertain relationship with some of these countries. The nation's net import reliance for selected commodities, as analyzed by the U. S. Bureau of Mines (1978) in a report entitled "Status of the Mineral Industries," is shown in Table 2. This report notes that net imports supply more than 50 percent of our consumption of 18 major nonfuel commodities. Imports provide from 85 to 100 percent of the U. S. consumption of certain vital materials such as columbium, cobalt, manganese, platinum-group metals, bauxite, chromium, and sheet mica.

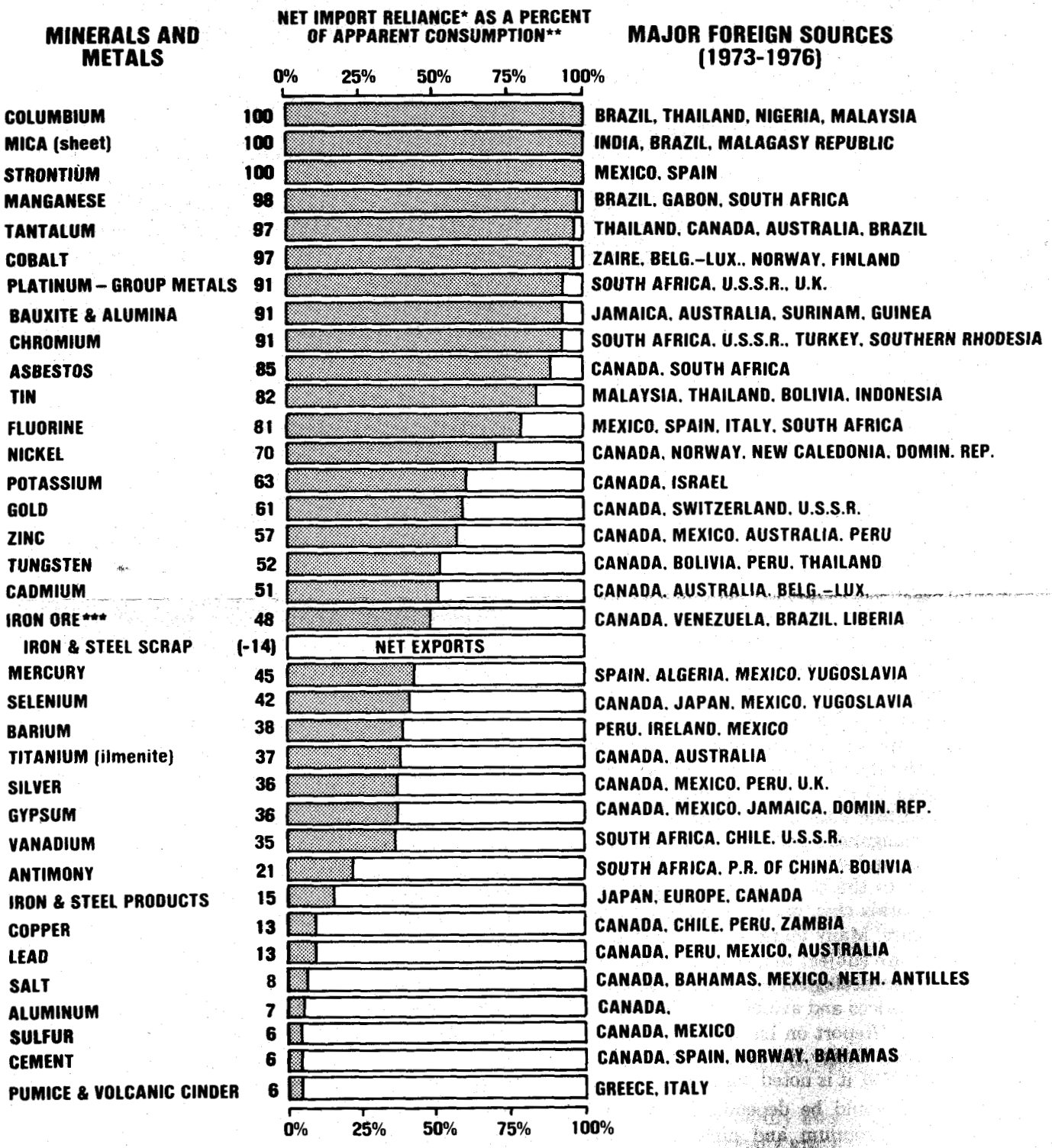
A major danger to the U. S. is that supplies of many critical minerals that must be imported are becoming less secure. Many materials are imported from nations that are subject to increasing political instability or are our ideological adversaries, making long-term mineral prices and availability uncertain. In a study entitled "Report on Issues Identified in the Nonfuel Minerals Policy Review," prepared for the White House (1979), it is noted, for example, that the United States would be dependent upon the Soviet Union for chromium and platinum-group metals if present supplies from South Africa should become unavailable. One has only to recall the shortages of certain key materials during World War II also, and the desperate attempts made to transport these materials over long distances under wartime conditions to realize the potential danger to the U. S. in import dependence. For this reason, the Federal Government maintains stockpiles of many strategic materials, including mineral commodities, as a partial solution to our import vulnerability.

MINERAL INDUSTRY PROBLEMS

Our domestic mineral position has been adversely affected by many problems in recent years. The American mineral industry is increasingly affected by inflation and higher costs for labor, equipment, services, and transportation and more recently by requirements for meeting the numerous environmental standards. This increased cost of doing business serves to limit the amount of capital available for the exploration and development of new deposits and for the modernization and expansion of production facilities. In some cases high costs have forced the closure of less profitable operations that nevertheless contributed to our mineral supply. Many operations have been shut down because of large investments that would be needed to bring them into compliance with air, water, or other environmental regulations. The higher costs make the existing industry less able to compete with foreign sources of materials. Some of these sources are subsized by their respective governments for economic or political purposes. In addition, the depletion of many of the higher-grade or more easily accessible deposits that were mined in the past in the U. S. has necessitated, in some cases, the use of lower grade or more distant materials, often with an accompanying increase in costs, energy requirements, and adverse environmental impact.

The location, evaluation, and development of new sources of materials is a basic activity of the mineral industry. These efforts are often extremely costly and time-consuming. Lead times of many years and the expenditure of millions of dollars may occur before a new mine or plant is brought into production. For example, new synthetic fuel plants may take from 4 to 8 years from the time a decision is made to build such a facility until first production is achieved. Prospective sites from which useful mineral materials might be obtained are increasingly precluded from such activity by competing land uses, high land values, or zoning restrictions. In many areas, materials are rendered physically inaccessible by human development such as urban or industrial growth; in essence they are "paved over." For example, deposits of sand and gravel have been covered by suburban growth in northern Virginia, resulting in the need to transport needed construction materials from more

Table 2. U. S. net import reliance of selected minerals and metals as a percent of consumption in 1977 (U. S. Bureau of Mines, 1978).



*NET IMPORT RELIANCE = IMPORTS-EXPORTS + ADJUSTMENTS FOR GOV'T AND INDUSTRY STOCK CHANGES

**APPARENT CONSUMPTION = U.S. PRIMARY + SECONDARY PRODUCTION + NET IMPORT RELIANCE.

***SUBSTANTIALLY HIGHER THAN NORMAL DUE TO STRIKES.

distant areas. Many potential deposits have been lost to future use by zoning or other land-use restrictions that preclude production of minerals or do not recognize their existence. Numerous deposits that might contribute to our mineral adequacy will not be utilized because of federal, state, or local environmental restrictions that discourage or prohibit mineral activities. Removal by the federal government of vast tracts of public land from mineral exploration or production activities has restricted the area in which we can search for and inventory the Nation's resources and has reduced our short-term potential supply of usable mineral materials.

INSURING ADEQUATE SUPPLIES

Adequate supplies of mineral resources must be available to the United States if we are to sustain the activities of our industrialized society and the well-being of our citizens. To meet this challenge, government and industry must formulate enlightened and realistic mineral policies to plan for and supply our long-range mineral needs. These policies should provide for the optimum development of our domestic resources but should be consistent with appropriate environmental practices. In order to establish a high degree of mineral independence, domestic mineral activities should be coordinated with sound import and stockpile practices for materials that cannot be supplied from within the United States or replaced by substitutes. Development and use of substitute materials to take the place of scarcer or more costly commodities should be pursued as a major research goal. Widespread, integrated conservation programs that involve both the recycling of industrial products and the repair rather than replacement of durable goods should be a basic cornerstone of our mineral policy.

The acquisition of basic knowledge through geologic field and laboratory studies and a continuing inventory of our known mineral resources should be accelerated. Exploration activities for minerals should be encouraged and techniques for locating and evaluating new sources of materials should be improved. As the most plentiful and highest-grade materials are consumed, our extractive and processing capabilities must be increased to permit the use of lower grade materials that are below today's economic or technologic limits. The practice of sequential land use should be encouraged. This concept provides for extraction of useful minerals where practical, followed by appropriate reclamation, before land is used for other purposes.

Various levels of governmental authority should recognize the need for appropriate mineral-resources development when land-use or other plans that affect resources are formulated. Because technology, markets, and mineral requirements are not static but change continually, land-use planning should provide for periodic re-evaluation and flexibility so that changing national needs may be met.

DIVISION OF MINERAL RESOURCES

In order to meet some of the mineral and fuel needs of the future, the Division of Mineral Resources has ongoing programs in the areas of geologic and topographic mapping, fossil fuels, mineral resources, geophysics, geochemistry, and in environmental geology. In general, the Division generates basic geologic, mineral, and topographic data through its research programs, collects and organizes data provided by other government agencies, educational institutions and industry, and disseminates geologic data through its publications and contacts with a wide variety of clients.

The primary method of collecting geologic data is through field work, both detailed quadrangle mapping and regional reconnaissance of large areas. In order to perform this function the Division has three mapping sections, one each in the Coastal Plain, Blue Ridge-Piedmont and in the Valley and Ridge. Experts in each of these areas comb the countryside for outcrops, and where necessary drill to bedrock to obtain samples. Detailed mineral resource inventories are made of the areas mapped. The geologic data are compiled for each quadrangle, and maps and reports are prepared for the areas studied.

Because of the increasing importance of fossil fuels the Division is currently conducting an inventory of the coal resources of the State, in cooperation with the U. S. Geological Survey. This program will lead to new estimates for coal resources by coal bed and county. Coal samples are being obtained and detailed analyses are made by the U. S. Geological Survey, and the U. S. Bureau of Mines. The Division maintains a file of oil and gas wells in the State, and is currently compiling this information in a form amenable for publication and computerization so that the data will be more generally available to the public and industry. Sets of drill cuttings from numerous oil and gas tests in the State are on file and available for study by interested geologists. The Division is working with the Department of Mining and Mineral Engineering at Virginia Tech, evaluating

the possibilities of producing methane from unmineable coal beds. The Division is also making studies of earth lineaments in southwestern Virginia and their relationship to occurrences of oil and gas.

In the area of nonfuel mineral resources the Division is working on a project to computerize its mineral resource data and incorporate it into the U. S. Geological Survey CRIB system. At a future date the Division will develop its own computerized mineral resources data bank which will be specifically tailored to the needs of the State. The Division is evaluating specific non-metallic and metallic mineral resources, such as clay-materials for ceramic purposes, sandstone and quartzite for high-silica products, and is preparing inventories of sulfide occurrences and other metallic mines and prospects. In past years the results of many similar studies of other commodities were published. In addition, the Division maintains files on a large volume of unpublished mineral resource information which is made available to its numerous clients.

Geophysical projects, studies of the gravity, magnetic field, and radioactivity of the State are performed both by means of contracts to geophysical companies and by detailed ground surveys by Division personnel. These different types of geophysical data are used to help interpret geologic data, locate and identify mineral prospects and to provide general information about the structure of the earth. In addition, the Geophysical Section maintains two seismic stations, a three-component station at Charlottesville and a vertical-component station at Front Royal. These are integrated into the Virginia Seismic network which is operated primarily by the Department of Geological Sciences at Virginia Tech. Also, data from the two stations are made available to the National Earthquake Information Service (USGS), Boulder, Colorado.

The Laboratory section of the Division performs numerous analyses on rocks and minerals in support of the geological mapping and mineral resources projects. In addition, laboratory personnel are currently studying a wide range of topics, such as the occurrence of massive sulfide deposits, radioactivity, stream sediment geochemistry, compositions of rocks and minerals, the occurrences of maganese and tin, and environmental problems related to mining. Studies such as these provide industry with general information which they can use in their own mineral resource programs.

The Division's Information Services section provides the public with geologic and topographic information about the State. The section works with educational institutions and groups interested in the geology and topography of the State, either at the Division's offices, or by visits and exhibits prepared for specific events. The topographic mapping program lies within the purview of the section. Virginia is one of a few states completely mapped with modern 7.5-minute topographic quadrangles (scale 1:24,000). The topographic mapping program is in cooperation with the U. S. Geological Survey. At present the emphasis of the program is in the revision of existing quadrangles on a five year basis and in obtaining a new series of intermediate-scale county base maps at a scale of 1:50,000. Whereas detailed quadrangle maps are ideally suited for a wide variety of field-oriented studies, the intermediate-scale maps are more suitable for regional compilations of mineral resources and fuels data and for planning at the county level.

Part of the Information Services Section's responsibility lies in the general area of environmental geology and land-use planning. Local and regional planners are informed about the mineral potential of their areas of interest and they are informed about geologically related natural hazards such as landslide prone areas and areas underlain by karst which may be subject to subsidence. As time and money permit, land-use maps are prepared and published, for example the recently published land modification map of Warren County.

Finally, the Division's activities result in a considerable publication effort that requires the work of draftsmen and a geologic editor. The Division maintains a rock, mineral and fossil "library" or repository which contains scientific samples collected over the years. In addition, a geologic library of over 4,000 volumes is maintained for use both by the Division's staff and by the public, in general.

R. C. Milici
D. C. Le Van

REFERENCES

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Gulf Oil Corporation, 1979, Some useful facts on energy: 60 tables.

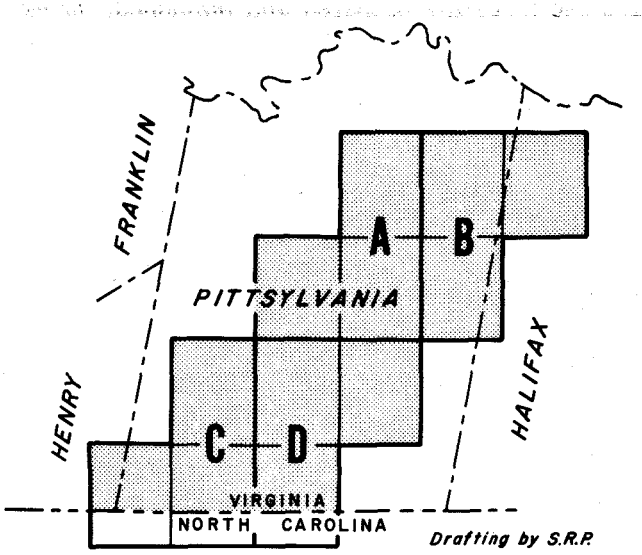
U. S. Bureau of Mines, 1978, Status of the mineral industries: 39 p.

RADIOMETRIC MAPS - DANVILLE AREA

An aeroradioactivity survey that covers approximately 600 square miles in parts of Henry, Halifax, and Pittsylvania counties is now available from the Virginia Division of Mineral Resources. The survey covers the southern three-fourths of the Virginia portion of the Daville basin. The results are presented on four separate maps, each at a scale of 1:62,500.

The survey was flown at 500 feet above terrain in an east-west direction with flight lines spaced one-half mile apart. A gamma-ray spectrometer with a 1000 cubic inch crystal system was utilized to record the total counts per second as well as the individual responses of potassium, thorium, and uranium. Radiometric maps are useful in determining the distribution of rock types, especially where they are covered by soil, and in locating of possible uranium occurences.

Maps may be ordered by 15-minute-area name (see illustration). These are available as ozalid copies for $2.08 each from the Virginia Division of Mineral Resources, Box 3667, Charlottesville, Virginia 22903. A composite mylar copy is also available for $15.60. Prices include 4 percent State sales tax.



A - CHATHAM 15′ RADIOMETRIC MAP (Covers Gretna, Chatham, and Spring Garden quadrangles)

B - RICEVILLE 15′ RADIOMETRIC MAP (Covers Mount Airy, Republican Grove and Java quadrangles)

C - DRAPER 15′ RADIOMETRIC MAP (Covers Whitmell, Draper, and Brosville quadrangles)

D - DANVILLE 15′ RADIOMETRIC MAP (Covers Mt. Hermon, Blairs, and Danville quadrangles)

CONTRIBUTIONS TO VIRGINIA GEOLOGY

The Division of Mineral Resources is currently accepting papers on Virginia geology from writers outside the Division for possible publication. Instructions on preparation of manuscripts and also review forms will be mailed upon written request. At least two reviews will need be procured by writers. Papers not accepted for publication may be placed on open file with the Division if writers wish to do so.

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NEW CAVE PROTECTION ACT

In January 1978 members of the Virginia Region of the National Speleological Society, alarmed by the accelerating degradation of Virginia's cave resources, asked The Honorable Bill Axselle of Richmond to introduce legislation into the Virginia General Assembly which would create a commission to study the conservation of cave resources. The legislation (House Joint Resolution No. 10) was passed in amended form and an eleven member commission was appointed by Governor Dalton to "study all problems incidental to cave use, protection, and conservation in Virginia."

The Commission on the Conservation of Caves completed its study in December 1978 and submitted its findings to the Governor and General Assembly (House Document No. 5, 1978). The Commission's report documented the rapid deterioration of Virginia's caves as geologic, archeologic, biologic, recreational, and educational resources. Further, the Commission made the following three recommendations: that an inventory of archeologic resources in Virginia caves be made, that a permanent Cave commission be created, and that a new Cave protection Act giving broader protection to cave resources be enacted.

The 1979 session of the General Assembly, responding to the recommendations of the Commission on the Conservation of Caves, created the Virginia Cave Commission and enacted the new comprehensive Cave Protection Act.

The new Virginia Cave Protection Act has two basic objectives - to protect Virginia's cave resources from vandalism and degradation and to protect the cave owner's interest in his property. Most violations of the law are Class 3 misdemeanors, punishable by a fine of up to five hundred dollars.

Under the provisions of this new law it is illegal to remove, mar, or otherwise disturb any natural mineral formation or sedimentary deposit in any cave without the owner's express, prior, written permission. Although collection of mineral specimens is not completely prohibited, it was the intent of the Commission on the Conservation of Caves that future collection be as minimal, selective, and scientific as possible. This law is designed to preserve the beauty of Virginia's caves and prevent them from being destroyed by indiscriminate collection and by vandalism.

It is also illegal to sell or export for sale speleothems (mineral formations or deposits found in caves) under the new Virginia Cave Protection Act. By eliminating the market for speleothems, much of the incentive for speleothem theft is also eliminated.

Caves are unique natural laboratories for the investigation of biologic processes. Natural organisms found in caves live in fragile environments where even small disturbances by man can produce catastrophic changes in cave ecosystems. Many of the more than 200 animal species found in Virginia caves are restricted to small geographical areas and occur in very small populations. A number of Virginia's cave animals, including three species of bats, have been placed on the Federal Endangered Species List. The new Cave Protection Act prohibits disturbing or harming any cave organism. Permits for the collection of biologic specimens can be obtained from the Cave Commission.

The pollution of groundwater as a result of the dumping of garbage, sewage, dead farm animals, and toxic wastes into caves and sinkholes is a problem in the limestone areas of Virginia. Caves provide natural conduits for groundwater flow, which concentrate groundwater pollutants. This contamination not only adversely affects man, but also organisms within the cave system. Under the new Virginia Cave Protection Act it is illegal to dump any litter, waste material, or toxic substance in any cave without the express, prior, written permission of the owner.

Virginia caves contain important archeologic sites. There are 26 known Indian-burial caves and at least 50 saltpetre caves in the State. Such cave can contain a wealth of scientific data on the prehistoric and historic cultures which used them. Unfortunately, much of the information that these sites could yield to trained scientists, may have been lost as a result of disturbance by vandals and souvenir hunters. To protect the remaining archeologic resources found in Virginia caves, the new Cave Protection Act requires a permit to be obtained from the Virginia Historic Landmarks Commission and written permission from the cave owner before excavating, removing, or disturbing any fossils, historic artifacts, or prehistoric remains.

The Cave Protection Act also protects gates, locks, and other barriers designed by the cave owner to prevent or to control access to his cave. It is illegal to break, force, or tamper with these barriers or to remove or deface any sign posted by the owner. The cave owner is also exempted from liability for any injury sustained in his cave as long as he has not charged an admission fee.

Below is the complete text of the new Virginia Cave Protection Act. If you have any questions regarding caves, the act or its enforcement, please write to the Virginia Cave Commission, c/o BSC, P. O. Box 6532, Charlottesville, Virginia 22906.

Robert W. Custard

CHAPTER 12.2

10-150.11. Findings and policy - The General Assembly hereby finds that caves are uncommon geologic phenomena, and that the minerals deposited therein may be rare and occur in unique forms of great beauty which are irreplaceable if destroyed. Also irreplaceable are the archeological resources in caves which are of great scientific and historic value. It is further found that the organisms which live in caves are unusual and of limited numbers; that many are rare and endangered species; and that caves are a natural conduit for grounwater flow and are highly subject to water pollution, thus having far-reaching effects transcending man's property boundaries. It is therefore declared to be the policy of the General Assembly and the intent of this chapter to protect these unique natural and cultural resources.

10-150.12. Definitions. - As used in this chapter, the following words shall have the meanings stated unless the context requires otherwise:

A. "Cave" means any naturally occurring void, cavity, recess, or system of interconnecting passages beneath the surface of the earth or within a cliff or ledge including natural subsurface water and drainage systems, but not including any mine, tunnel, aqueduct, or other man-made excavation, which is large enough to permit a person to enter. The word "cave" includes or is synonymous with cavern, sinkhole, natural pit, grotto, and rock shelter.

B. "Commercial cave" means any cave utilized by the owner for the purposes of exhibition to the general public as a profit or nonprofit enterprise, wherein a fee is collected for entry.

C. "Gate" means any structure or device located to limit or prohibit access or entry to any cave.

D. "Sinkhole" means a closed topographic depression or basin, generally draining underground, including, but not restricted to, a doline, uvala, blind valley, or sink.

E. "Person" or "persons" means any individual, partnership, firm, association, trust, or corporation or other legal entity.

F. "Owner" means a person who owns title to land where a cave is located, including a person who owns title to a leasehold estate in such land, and specifically including the Commonwealth

and any of its agencies, departments, boards, bureaus, commissions, or authorities, as well as counties, municipalities, and other political subdivisions of the Commonwealth.

G. "Speleothem" means a natural mineral formation or deposit occurring in a cave. This includes or is synonymous with stalagmite, stalactite, helectite, shield, anthodite, gypsum flower and needle, angel's hair, soda straw, drapery, bacon, cave pearl, popcorn (coral), rimstone dam, column, palette, flowstone, et cetera. Speleothems are commonly composed of calcite, epsomite, gypsum, aragonite, celestite, and other similar minerals.

H. "Speleogen" means an erosional feature of the cave boundary and includes or is synonymous with anastomoses, scallops, rills, flutes, spongework, and pendants.

I. "Material" means all or any part of any archeological, paleontological, biological, or historical item including, but not limited to, any petroglyph, pictograph, basketry, human remains, tool, beads, pottery, projectile point, remains of historical mining activity or any other occupation, found in any cave.

J. "Cave life" means any life form which normally occurs in uses, visits, or inhabits any cave or subterranean water system, excepting those animals and species covered by any of the game laws of the Commonwealth.

10-150.13. Vandalism; penalties. - A. It shall be unlawful for any person, without express, prior, written permission of the owner, to:

1. Break, break off, crack, carve upon, write, burn, or otherwise mark upon, remove, or in any manner destroy, disturb, deface, mar, or harm the surfaces of any cave or any natural material which may be found therein, whether attached or broken, including speleothems, speleogens, and sedimentary deposits. The provisions of this section shall not prohibit minimal disturbance for sceintific exploration.

2. Break, force, tamper with, or otherwise disturb a lock, gate, door, or other obstruction designed to control or prevent access to any cave, even though entrance thereto may not be gained.

3. Remove, deface, or tamper with a sign stating that a cave is posted or citing provisions of this chapter.

B. The entering or remaining in a cave which has not been posted by the owner shall not by itself constitute a violation of this section.

C. Any violation of this section shall be punished as a Class 3 misdemeanor.

10-150.14 Pollution unlawful; penalties. - A. It shall be unlawful for any person without express, prior written permission of the owner to store, dump, litter, dispose of or otherwise place any refuse, garbage, dead animals, sewage, toxic substances harmful to cave life or humans in any cave or sinkhole. It shall also be unlawful to burn within a cave or sinkhole any material which produces any smoke or gas which is harmful to any naturally occurring organism in any cave.

B. Any violation of this section shall be punished as a Class 3 misdemeanor.

10-150.15. Biological policy; penalties for violation. - A. It shall be unlawful to remove, kill, harm, or otherwise disturb any naturally occuring organisms within any cave, except for safety or health reasons; provided, however, scientific collecting permits may be obtained from any cave commission established for such purpose or form the appropriate State agency.

B. Any violation of this section shall be punished as a Class 3 misdemeanor.

10-150.16. Archeology; permits for excavation; how obtained; penalties for violation. - A. In order to protect the archeological resources not covered by the Virginia Antiquities Act (10-150.1 et seq.), it shall be unlawful to excavate, remove, destroy, injure, deface, or in any manner disturb any burial grounds, historic or prehistoric resources, archeological or paleontological site or any part thereof, including relics, inscriptions, saltpetre workings, fossils, bones, remains of historical human activity, or any other such features which may be found in any cave, except those caves owned by the Commonwealth or designated as Commonwealth archeological sites or zones, and which are subject to the provisions of the Virginia Antiquities Act. Any violation of this subsection shall be punished as a Class 3 misdemeanor.

B. Notwithstanding the provisions of subsection A. hereof, a permit to excavate or remove archeological, paleontological prehistoric, and historic features may be obtained from the Virginia Historic Landmarks Commission. The Commission may issue a permit to conduct field investigations if the Commission finds that it is in the best interest of the Commonwealth, that the applicant meets the criteria of this section and the applicant is an historic, scientific, or educational institution, professional archeologist or amateur, who is qualified and recognized in the areas of field investigations or archeology. Such permit shall be issued for a period of two years and may be renewed upon expiration. Such permit shall not be transferrable; provided, however, the provisions of this section shall not preclude any person from working under the direct supervision of the permittee.

C. All field investigations, explorations, or recovery operations undertaken under this section shall be carried out under the general supervision of the Commissioner of Archeology of the Virginia Research Center for Archeology and the Virginia Historic Landmarks Commission and in a manner to insure that the maximum amount of historic, scientific, archeologic, and educational information may be recovered and preserved in addition to the physical recovery of objects.

D. A person applying for a permit pursuant to this section shall:

1. Have knowledge of archeology or history as qualified in subsection b. hereof.

2. Provide a detailed statement to the Commission giving the reasons and objectives for excavation or removal and the benefits expected to be obtained from the contemplated work.

3. Provide data and results of any completed excavation, study, or collection at the first of each calendar year.

4. Obtain the prior written permission of the owner if the site of the proposed excavation is on privately owned land.

5. Carry the permit while exercising the privileges granted.

E. Any violation of subsection A. hereof shall be punished as a Class 3 misdemeanor. Any violation of subsection D. hereof shall be punished as a Class 4 misdemeanor, and the permit shall be revoked.

F. The provisions of this section shall not apply to any person in any cave located on his own property.

10-150.17. Sale of speleothems unlawful; penalties. - It shall be unlawful for any person to sell or offer for sale any speleothems in this Commonwealth, or to export them for sale outside the Commonwealth. Any violation of this section shall be punished as a Class 3 misdemeanor.

10-150.18. Liability of owners and agents limited. - A. Neither the owner of a cave or his authorized agents acting within the scope of their authority are liable for injuries sustained by any person using the cave for recreational or scientific purposes if no charge has been made for the use of the cave, notwithstanding that an inquiry as to the experience or expertise of the individual seeking consent may have been made.

Nothing in this section shall be construed to constitute a wavier of the sovereign immunity of the Commonwealth or any of its boards, departments, bureaus, or agencies.

2. That 18.2-142 of the Code of Virginia is repealed.

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VIRGINIA MINERALS AVAILABLE

Beginning January 1980, extra issues of **Virginia Minerals** will be available at a cost of $0.52 each (includes four precent State sales tax). Reproducible machine copies will be provided for any issue which has been depleted. An index to the issues is available free upon request from the Division.

COAL RESERVE REVISION

The Virginia Division of Mineral Resources has begun a program of revising the coal reserve estimates for the Southwest Virginia Coal Field in cooperation with the U. S. Geological Survey. Results of this study will be useful to all levels of government, mining companies and mining equipment and service suppliers in anticipating future coal development in Virginia. The last estimate of coal reserves was made by the U. S. Geological Survey and was published in 1952.

As a first step in gathering data for the reserve estimate, Division geologists are visting all working coal mines in the State. At each mine, geological data on coal thickness, quality and development potential will be collected. Division personnel will also measure and describe available coal exposures in road cuts and streams. The Division's published report will consist of calculated reserve tables compiled by county and coal bed. Data reported will not disclose the amount of coal present or previously mined on individual properties. The Division of Mineral Resources has enjoyed good working relationship with Virginia's coal operators and anticipates continued invaluable company cooperation in this project.

APPALACHIAN SULFIDE DEPOSIT MAP AVAILABLE

The Division of Mineral Resources has received an open file copy of a black and white version of "Lithostratigraphic, Structural Setting of Stratabound (Massive) sulfide Deposits, U. S. Appalachians," by Jacob E. Gair and John F. Slack, U. S. Geological Open File Report 79-1517. The report consists of two map sheets on a scale of 1:1,000,000 showing 103 sulfide deposits from Alabama to Maine; 13 of these are in Virginia. The deposits are grouped by size and by base metal and iron sulfide content. Two additional sheets in the report give the following details in tabular form: tectonic unit or postion; age of host rock; general host rock lithology; metamorphic grade; shape; size; mode of aggregation; dominant iron-sulfide; grade for S, Cu, Zn, Pb, Au, Ag; other elements of special interest; comments on history and geology; and references. The deposits are plotted on a generalized geologic map depicting regionally correlated lithologies and plutons of similar age with explanatory legend.

The report is a product of the International Geological Correlation Programme (IGCP) Project No. 60 on the correlation of Caledonian stratabound sulfides. The maps and tables correspond to similar maps and tables for the Caledonian orogen for Canada, Greenland, Ireland, Scotland, Norway, and Sweden being produced by national groups involved in the international project.

These maps may be seen in the Division's library or purchased from:

Open File Services
Branch of Distribution
Box 25425
Federal Center
Denver, Colorado 80225

Phone: 303-234-5888