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NORTH ATLANTIC REGIONAL WATER RESOURCES STUDY. APPENDIX H. MINE--ETC(U)
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North Atlantic Regional Water Resources Study

Appendix H
Minerals

The North Atlantic Regional Water Resources (NAR) Study examined a wide variety of water and related land resources, needs and devices in formulating a broad, coordinated program to guide future resource development and management in the North Atlantic Region. The Study was authorized by the 1965 Water Resources Planning Act (PL 89-80) and the 1965 Flood Control Act (PL 89-298), and carried out under guidelines set by the Water Resources Council.

The recommended program and alternatives developed for the North Atlantic Region were prepared under the direction of the NAR Study Coordinating Committee, a partnership of resource planners representing some 25 Federal, regional and State agencies. The NAR Study Report presents this program and the alternatives as a framework for future action based on a planning period running through 2020, with bench mark planning years of 1980 and 2000.

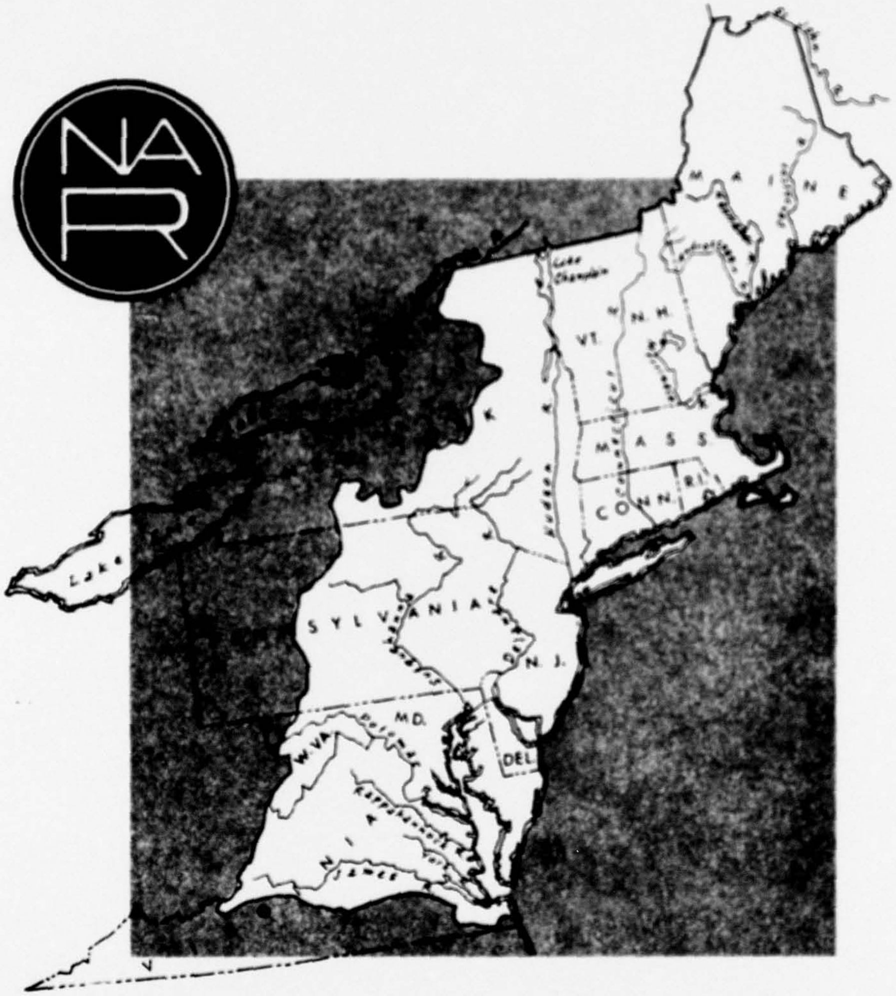
The planning partners focused on three major objectives -- National Income, Regional Development and Environmental Quality -- in developing and documenting the information which decision-makers will need for managing water and related land resources in the interest of the people of the North Atlantic Region.

In addition to the NAR Study Main Report and Annexes, there are the following 22 Appendices:

A. History of Study
B. Economic Base
C. Climate, Meteorology and Hydrology
D. Geology and Ground Water
E. Flood Damage Reduction and Water Management for Major Rivers and Coastal Areas
F. Upstream Flood Prevention and Water Management
G. Land Use and Management
H. Minerals
I. Irrigation
J. Land Drainage
K. Navigation
L. Water Quality and Pollution
M. Outdoor Recreation
N. Visual and Cultural Environment
O. Fish and Wildlife
P. Power
Q. Erosion and Sedimentation
R. Water Supply
S. Legal and Institutional Environment
T. Plan Formulation
U. Coastal and Estuarine Areas
V. Health Aspects

WATER RESOURCES NEEDS AND POTENTIALS FOR AN EXPANDING SOCIETY

Appendix H
Minerals



Prepared by

Bureau of Mines
United States Department of the Interior

for the

NORTH ATLANTIC REGIONAL WATER RESOURCES STUDY
COORDINATING COMMITTEE

SYLLABUS

The mineral industry of the North Atlantic Region is important to both the local and the national economy, with total production valued at $1.3 billion in 1970. The leading commodities were anthracite, bituminous coal, cement, crushed stone, and sand and gravel. The high-level production of construction materials reflects the urban-industrial density of the Region. Other important mineral commodities were iron ore, lime, dimension stone, and zinc. Future mineral production potential is good within the Region and the opening of new mines can be anticipated. Technologic developments in mineral extraction and processing will play a part in expanding the development of mineral resources, but a timetable of such events cannot be made at present.

An adequate water supply is essential to the production of most mineral commodities, and mineral deposits are usually not considered to be viable if water is not available. Mineral processing causes little consumptive loss of water but, like all uses of water, it degrades the quality to some degree. The extent of degradation of process water can be maintained within tolerable limits. The presence of sulfide minerals in and adjacent to the mineral being mined has caused serious pollution problems locally, and, in the case of coal, many miles of streams have been adversely affected. Depleted and abandoned coal mines are the principal contributors of water pollutants at present. State agencies with Federal help have programs underway to abate pollution from abandoned mines. Adequately enforced regulations and preplanning to avoid pollution can minimize degradation of water by operating mines. Preplanning should include provision for an effective shutdown program designed to prevent the mine and waste piles from becoming a pollution source when the mine is closed down or abandoned.

Areas and sites known to contain minerals have been described and shown on maps to aid future planning for individual river basins. Principal emphasis has been given to those minerals whose recovery requires the use of water or may affect water. Of special concern to planners will be the availability of low-priced construction materials without which economic development is retarded. In some of the Basins of NAR, construction materials are in short supply at present, and importation of these commodities at higher cost will be necessary in the near future.

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CHAPTER 1

INTRODUCTION

This report has been compiled by the United States Bureau of Mines at the request of the U.S. Army Corps of Engineers, and is a general appraisal of the mineral resources of the North Atlantic Region (NAR). Data were compiled on the water-related mineral commodities and their resources. Emphasis was placed on those minerals whose production or processing involves the use of significant quantities of water, or may cause water pollution, or may result in solid waste disposal problems.

The study covers the mineral industry in all New England States, New Jersey, Delaware, and those portions of New York, Pennsylvania, Maryland, Virginia, and West Virginia that are in the New England and Middle Atlantic Areas established by the Water Resources Council and designated as the North Atlantic Region (fig. H-1). The study includes the analysis of data on water use by the mining industry and its waste water disposal problem.

General localities where mineral deposits occur in the Region are illustrated. The relationship of mineral production to water resources has been stressed. Distribution of fuels and minerals, metallic and nonmetallic, and the outlook for their use are described briefly. The problem of pollution including coal mine drainage is briefly discussed.

Data were compiled on the quantity and value of minerals produced in the Region in 1964. In some cases more recent data have been added in the text. Time and funding did not permit complete updating and rewriting to present more recent data. However, a table was prepared to show value of mineral production for all counties in NAR in 1969 and 1970. Water use data for 1962, obtained by canvassing mineral producers, were used to estimate future water requirements based on projections of mineral production, or in some cases, the best professional judgment available.

All data used in the report were obtained from Bureau of Mines publications and files, and from other Federal and State reports. No field examinations of mineral occurrences or mining operations were made.

Most of the data presented are as complete and broad as possible, and the report is not intended to be a detailed commodity or geologic report, nor a guide to exploration. The information presented is intended to meet the requirements of the North Atlantic Regional Water Resource Study planners and serve as a basis for future studies of mineral resources as related to water resource development in the Region. Later studies of individual river basins in the Region will require a comprehensive and detailed report on mineral resources and their relation to water, the economy, the environment, and land use.

CHAPTER 2

IMPORTANCE OF THE MINERAL INDUSTRY TO THE ECONOMY OF THE REGION

SIZE AND IMPORTANCE

Value of mineral production in NAR in 1964 was $1,167 million, about 5 percent of the United States total of $20,472 million. Of the nonmetallic mineral commodities produced both regionally and nationally, nearly 19 percent of the national nonmetals value was credited to NAR (Table H-1). The principal mineral commodities mined in the Region, in descending order of value, were stone, cement, sand and gravel, coal, iron, and zinc. In 1970, value of mineral production in NAR totaled $1,295 million, 4 percent of the United States total of $29,791 million.

Commodities produced in NAR, each of whose value exceeded more than half of the total value of United States production, were aplite, anthracite, asbestos, cobalt, emery, garnet, greensand marl, kyanite, manganiferous residuum, titanium concentrates, and wollastonite.

Coal and natural gas made up nearly 25 percent of the mineral value in NAR; crushed stone, 21 percent; cement, 20 percent; and sand and gravel, 12 percent. Metallic mineral production accounted for only 10 percent of the total value. Table H-1 shows 1964 production and value of mineral commodities in NAR and, for comparison, data for national production of the same minerals. Table H-2 shows 1969 and 1970 value of mineral production by counties in NAR with a listing of 1970 minerals in decreasing order of value.

According to the Office of Business Economics, United States Department of Commerce, more than 53,000 people were employed in the mining industry in NAR in 1960. More than half the mineral industry employment was concentrated in the Susquehanna (Basin 17), and Delaware (Basin 15) River Basins and was attributed chiefly to coal mining. The remainder of the mineral industry employees are distributed throughout the Region and are engaged chiefly in stone quarrying and in the mining and processing of sand and gravel.

FUTURE DEVELOPMENT

In the United States, population growth and increased income have been accompanied by increased mineral consumption. The United States accounts for one-third to one-half of the non-Communist world's total consumption of the principal mineral commodities. The consumption of metals, nonmetals, and fuels is expected to increase through the year 2020.


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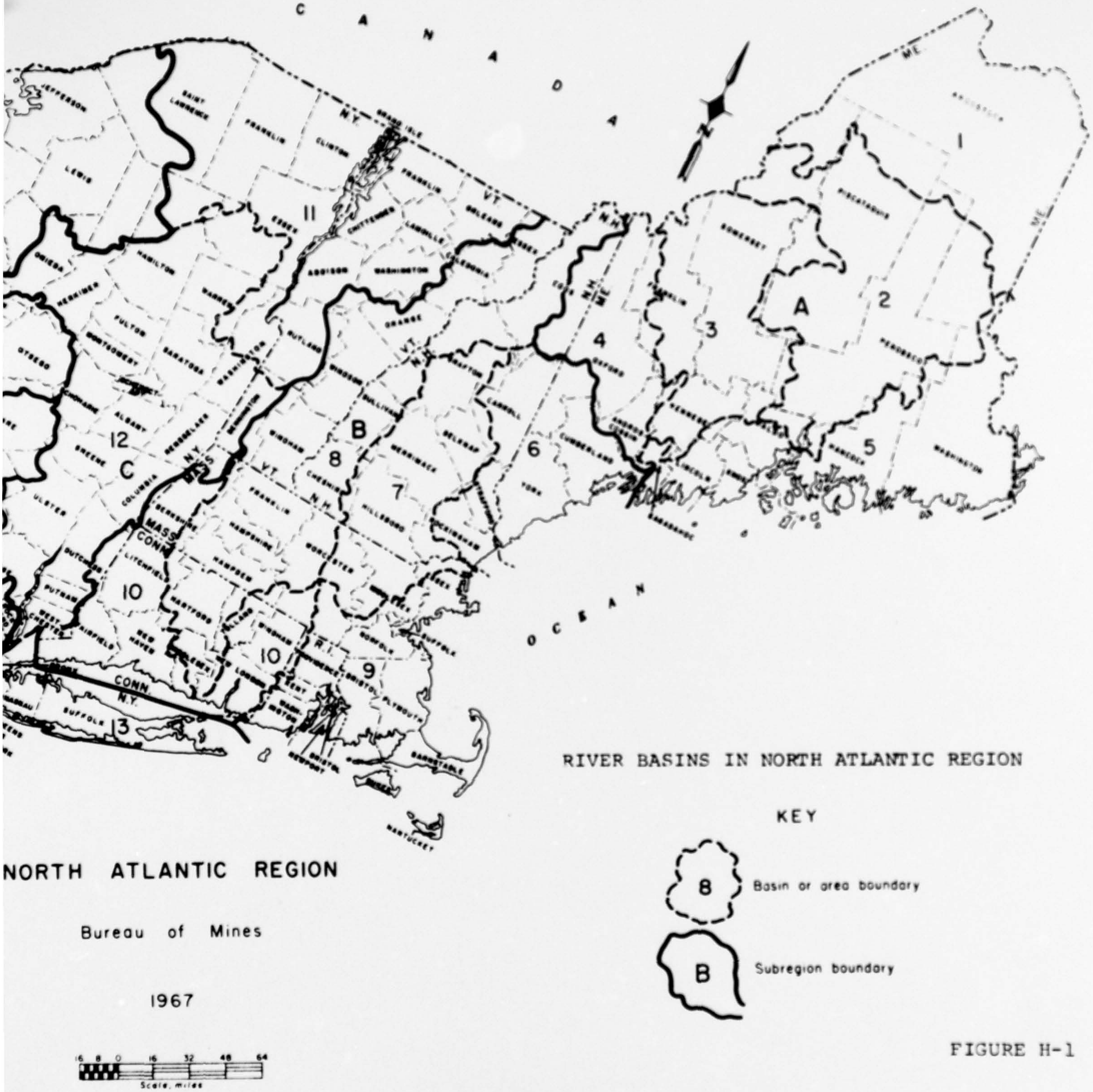
TUCKER
RANDOLPH
POCAHONTAS
PENDLETON
GREENBRIER
MONROE
GILES
MONTGOMERY
ROANOKE
BOTETOURT
CRAIG
ALLEGHANY
BATH
HIGHLAND
AUGUSTA
ROCKINGHAM
ROCKBRIDGE
SHENANDOAH
MINERAL
HARDY
FREDERICK
CLARKE
WARREN
RAPPAHANNOCK
NELSON
AMHERST
BEDFORD
CAMPBELL
APPOMATTOX
BUCKINGHAM
ALBEMARLE
FLUVANNA
LOUISA
ORANGE
CULPEPER
SPOTSYLVANIA
CAROLINE
PRINCE WILLIAM
FAIRFAX
LOUDOUN
MONTGOMERY
CHARLES
ST MARYS
CALVERT
TALBOT
DORCHESTER
CAROLINE
KENT
SUSSEX
WICOMICO
SOMERSET
WORCESTER
ACCOMACK
NORTHAMPTON
CUMBERLAND
POWHATAN
GOOCHLAND
HANOVER
HENRICO
AMELIA
PRINCE EDWARD
CHARLOTTE
NOTTOWAY
LUNENBURG
DINWIDDIE
CHESTERFIELD
PRINCE GEORGE
SUSSEX
SOUTHAMPTON
NANSEMOND
NORFOLK
PR. ANNE
ISLE OF WIGHT
HAMPTON
WARWICK
KING & QUEEN
ESSEX
RICHMOND
MIDDLESEX
GLOUCESTER
LANCASTER
CHARLES CITY
FULTON
FRANKLIN
CUMBERLAND
PERRY
JUNIATA
MIFFLIN
YORK
LANCASTER
CHESTER
BERKS
BUCKS
NEW CASTLE
SALEM
CUMBERLAND
ATLANTIC
BURLINGTON
CAPE MAY
CENTRE
CLINTON
ELK
POTTER
TIOGA
STEUBEN
ALLEGANY
BRADFORD
CLEARFIELD
CAMBRIA
BLAIR
SOMERSET
BERKELEY
JEFFERSON
UNION
ESSEX
NEW YORK



RIVER BASINS IN NORTH ATLANTIC REGION

FIGURE H-1

TABLE H-1

Mineral Production in the North Atlantic Region and Comparable United States Production in 1964 1/ 2/

Commodity	North Atlantic		United States		North Atlantic Percent of the United States	
	Quantity (thousands)	Value (thousands)	Quantity (thousands)	Value (thousands)	Quantity	Value
Cement:						
Portland....................376-pound barrels..	70,956	$214,415	366,304	$1,168,987	19.4	18.3
Masonry....................280-pound barrels..	5,308	14,043	22,397	63,305	23.7	22.2
Clays..............................short tons..	6,212	16,795	52,853	192,539	11.8	8.7
Coal:						
Anthracite.................................do....	17,184	148,648	17,184	148,648	100.0	100.0
Bituminous.................................do....	31,073	137,744	486,998	2,165,582	6.4	6.4
Copper.....................................do....	4	2,356	1,247	812,901	0.3	0.3
Emery......................................do....	9	172	9	172	100.0	100.0
Feldspar.............................long tons..	96	847	587	5,389	16.3	15.7
Gem stones......................................	NA	97	NA	1,474	----	6.5
Iron Ore (usable).......long tons, gross weight..	4,941	71,060	84,300	802,331	5.9	8.9
Lead (recoverable content of ores, etc.)........................short tons..	1	192	286	74,936	0.3	0.3
Lime.......................................do....	3,024	38,552	16,089	223,167	18.8	17.3
Natural gas.................million cubic feet..	14	3,792	15,547	2,387,689	0.1	0.2
Peat..............................short tons..	88	991	640	6,198	13.8	16.0
Salt.......................................do....	4,654	28,833	31,623	200,706	14.7	14.4
Sand and gravel:						
Commercial.................................do....	105,595	134,269	621,392	700,051	17.0	19.2
Government-and-contractor..................do....	25,126	9,646	247,387	194,041	10.2	5.0
Stone:						
Crushed....................................do....	142,940	243,724	722,724	1,037,365	19.8	23.5
Dimension..................................do....	734	37,343	2,545	96,970	28.8	38.5
Talc 3/....................................do....	415	2,469	890	6,218	46.6	39.7
Zinc (recoverable content of ores, etc.) 4/............................do....	124	33,805	575	156,308	21.6	21.6
Value of items that cannot be disclosed: Aplite, asbestos, cement (natural), cobalt, abrasive garnet, gold, greensand marl, kyanite, magnesium compounds, manganiferous residuum, mica, potassium salts, pyrites, silver, titanium concentrates, tripoli, and wollastonite........	XX	26,815	XX	301,180	XX	8.9
Grand total..................................	XX	$1,166,608	XX	$10,746,157	XX	10.9

NA Not available. XX Not applicable.

1/ Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

2/ Includes some peripheral counties.

3/ Includes soapstone and sericite-schist.

4/ Includes recoverable zinc valued at yearly average price of Prime Western slab zinc, East St. Louis market. Represents value established after transportation, smelting, and manufacturing charges have been added to the value of ore at the mine.

TABLE H-2

Value of Mineral Production in North Atlantic Region, by counties

(thousand dollars)

State and County	1969	1970	Minerals produced in 1970 in order of value
Maine			
Androscoggin.....	$ 559	$ 885	Sand and gravel, clays
Aroostook........	664	633	Sand and gravel
Cumberland.......	1,747	2,472	Sand and gravel, stone, clays
Franklin.........	215	W	Sand and gravel
Hancock..........	W	6,345	Copper, zinc, sand and gravel, silver, peat, clays
Kennebec.........	691	1,086	Sand and gravel, stone
Knox.............	W	W	Cement, stone, sand and gravel
Lincoln..........	140	W	Sand and gravel
Oxford...........	323	223	Sand and gravel, feldspar, beryllium
Penobscot........	812	725	Sand and gravel
Piscataquis......	W	W	Stone, sand and gravel
Sagadahoc........	W	W	Sand and gravel
Somerset.........	W	W	Do.
Waldo............	334	W	Do.
Washington.......	W	W	Sand and gravel, peat
York.............	712	W	Sand and gravel
Undistributed1/..	13,988	11,410	
New Hampshire			
Belknap..........	W	W	Sand and gravel
Carroll..........	W	W	Sand and gravel, stone
Cheshire.........	W	W	Sand and gravel, mica
Coos.............	171	184	Sand and gravel
Grafton..........	677	677	Sand and gravel, stone, clays, mica
Hillsboro........	2,513	3,086	Stone, sand and gravel
Merrimack........	2,280	2,051	Sand and gravel, stone
Rockingham.......	959	900	Stone, sand and gravel, clays
Strafford........	256	275	Sand and gravel, clays
Sullivan.........	W	147	Sand and gravel
Undistributed1/..	1,265	1,410	
Vermont			
Addison..........	W	128	Sand and gravel
Bennington.......	W	610	Do.
Caledonia........	W	W	Do.

TABLE H-2

Value of Mineral Production in North Atlantic Region, by counties
(continued)

(thousand dollars)

State and County	1969	1970	Minerals produced in 1970 in order of value
Vermont (continued)			
Chittenden	$ 1,314	$ 938	Sand and gravel, stone, clay
Essex	W	W	Sand and gravel
Franklin	W	W	Stone, sand and gravel
Grand Isle	---	---	
Lamoille	W	W	Talc, sand and gravel
Orange	W	W	Stone, sand and gravel
Orleans	W	W	Asbestos, sand and gravel, stone
Rutland	W	W	Stone, sand and gravel
Washington	W	W	Do.
Windham	W	W	Sand and gravel, talc
Windsor	W	W	Talc, stone, sand and gravel, peat
Undistributed[1]	26,444	26,167	
Massachusetts			
Barnstable	W	604	Sand and gravel
Berkshire	8,321	8,211	Stone, lime, sand and gravel
Bristol	3,626	3,949	Sand and gravel, stone
Dukes	W	W	Sand and gravel
Essex	3,802	3,981	Stone, sand and gravel
Franklin	1,158	1,521	Sand and gravel, stone
Hampden	4,423	5,210	Stone, sand and gravel
Hampshire	608	622	Sand and gravel, stone
Middlesex	13,648	13,800	Stone, sand and gravel
Nantucket	4	6	Sand and gravel
Norfolk	5,546	5,667	Stone, sand and gravel, clays
Plymouth	994	936	Sand and gravel, clays, stone
Suffolk	453	821	Stone, sand and gravel
Worcester	5,716	4,023	Sand and gravel, stone, peat
Undistributed[1]	1,546	1,011	
Rhode Island			
Bristol	---	---	
Kent	1,701	1,628	Sand and gravel
Newport	W	W	Sand and gravel, stone
Providence	2,022	2,032	Do.
Washington	W	W	Stone, sand and gravel
Undistributed[1]	710	726	

TABLE H-2

Value of Mineral Production in North Atlantic Region, by counties (continued)

(thousand dollars)

State and County	1969	1970	Minerals produced in 1970 in order of value
Connecticut			
Fairfield........	$ 1,164	$ 936	Sand and gravel
Hartford.........	8,978	8,801	Stone, sand and gravel, clays
Litchfield.......	3,195	3,486	Stone, sand and gravel, lime
Middlesex........	1,801	1,747	Feldspar, sand and gravel, clays, mica, stone
New Haven........	9,167	9,679	Stone, sand and gravel, clays
New London.......	1,264	1,310	Stone, sand and gravel
Tolland..........	W	W	Sand and gravel
Windham..........	W	W	Stone, sand and gravel
Undistributed1/..	2,200	2,424	
New York			
Albany...........	W	W	Cement, stone, clays, sand and gravel
Bronx............	---	---	
Broome...........	1,616	1,210	Sand and gravel, stone, clays
Chemung..........	W	1,494	Sand and gravel
Chenango.........	W	299	Do.
Clinton..........	W	W	Stone, sand and gravel
Columbia.........	W	W	Cement, stone, sand and gravel, clays
Cortland.........	W	W	Sand and gravel
Delaware.........	1,390	1,503	Stone, sand and gravel
Dutchess.........	W	W	Do.
Essex............	W	W	Iron ore, ilmenite, sand and gravel, wollastonite, stone, garnet
Franklin.........	W	W	Sand and gravel, stone
Fulton...........	193	228	Do.
Greene...........	21,553	19,994	Cement, stone
Hamilton.........	---	---	
Herkimer.........	W	W	Stone, sand and gravel
Kings............	---	---	
Madison..........	838	W	Stone, sand and gravel
Montgomery.......	W	W	Do.
Nassau...........	4,768	W	Sand and gravel, clays
New York.........	---	---	
Oneida...........	2,439	W	Stone, sand and gravel
Orange...........	1,963	W	Sand and gravel, stone, peat

TABLE H-2

Value of Mineral Production in North Atlantic Region, by counties (continued)

(thousand dollars)

State and County	1969	1970	Minerals produced in 1970 in order of value
New York (continued)			
Otsego..........	W	$ 152	Sand and gravel
Putnam..........	W	W	Do.
Queens..........	---	---	
Rensselaer.......	$ 1,158	W	Sand and gravel, stone
Richmond.........	W	---	
Rockland.........	9,452	9,701	Stone, sand and gravel
St. Lawrence.....	r/36,432	33,671	Zinc, iron ore, talc, stone, sand and gravel, lead, silver, mercury
Saratoga.........	1,357	W	Stone, sand and gravel
Schenectady......	545	478	Sand and gravel
Schoharie........	W	W	Cement, stone, clays, sand and gravel
Steuben..........	1,080	W	Sand and gravel, stone
Suffolk..........	4,153	2,143	Sand and gravel
Sullivan.........	W	W	Stone, sand and gravel
Tioga............	442	604	Sand and gravel
Ulster...........	W	W	Cement, stone, clays, sand and gravel
Warren...........	W	W	Cement, garnet, stone
Washington.......	1,302	W	Stone, sand and gravel
Westchester......	809	W	Stone, sand and gravel, emery, peat
Undistributed[3/]..	141,278	163,409	
New Jersey			
Atlantic.........	516	254	Sand and gravel
Bergen...........	1,941	1,749	Do.
Burlington.......	1,842	1,700	Sand and gravel, clays
Camden...........	2,092	1,256	Do.
Cape May.........	W	W	Magnesium compounds, sand and gravel
Cumberland.......	12,579	11,960	Sand and gravel, clays
Essex............	W	W	Stone
Gloucester.......	559	573	Sand and gravel, greensand marl
Hudson...........	W	W	Stone
Hunterdon........	W	3,253	Do.
Mercer...........	W	W	Do.
Middlesex........	2,421	2,043	Sand and gravel, clays
Monmouth.........	1,201	1,347	Sand and gravel

TABLE H-2

Value of Mineral Production in North Atlantic Region, by counties (continued)

(thousand dollars)

State and County	1969	1970	Minerals produced in 1970 in order of value
New Jersey (continued)			
Morris..........	$ 7,565	$ 7,735	Sand and gravel, stone
Ocean...........	6,040	4,168	Sand and gravel, ilmenite
Passaic..........	5,838	6,194	Stone, sand and gravel
Salem............	---	---	
Somerset.........	14,706	18,436	Stone, clays
Sussex..........	13,360	15,141	Zinc, stone, sand and gravel, lime, peat, manganiferous residuum
Union...........	W	W	Stone
Warren...........	938	1,832	Sand and gravel, peat, stone
Undistributed[2]..	11,543	11,640	
Pennsylvania			
Adams...........	W	W	Stone, lime, clays, sericite-schist
Bedford..........	W	W	Stone, coal, lime, sand and gravel
Berks...........	W	W	Iron ore, cement, stone, clays, coal, sand and gravel, pyrites, cobalt
Blair...........	2,138	2,110	Stone
Bradford.........	W	W	Sand and gravel
Bucks...........	12,376	W	Stone, sand and gravel, clays
Cameron..........	---	---	
Carbon...........	5,450	5,318	Coal, sand and gravel, stone
Centre...........	21,808	23,581	Lime, coal, stone, clays
Chester..........	W	W	Stone, lime, clays
Clearfield.......	27,564	34,372	Coal, clays
Clinton..........	W	W	Coal, stone, clays
Columbia.........	3,982	W	Coal, stone, sand and gravel, peat
Cumberland.......	3,021	W	Stone, sand and gravel, clays
Dauphin..........	3,253	W	Stone, coal, sand and gravel, clays
Delaware.........	W	W	Stone
Franklin.........	1,581	W	Stone, sand and gravel
Fulton...........	W	W	Do.
Huntingdon.......	W	W	Sand and gravel, stone, clays
Juniata..........	---	---	

TABLE H-2

Value of Mineral Production in North Atlantic Region, by counties
(continued)

(thousand dollars)

State and County	1969	1970	Minerals produced in 1970 in order of value
Pennsylvania (continued)			
Lackawanna.......	W	W	Coal, peat, sand and gravel
Lancaster........	$ 10,794	$ 10,499	Stone, coal, clays, sand and gravel
Lebanon..........	23,850	W	Iron ore, lime, copper, stone, cobalt, pyrites, gold, silver
Lehigh...........	34,654	32,842	Cement, zinc, stone
Luzerne..........	37,769	35,212	Coal, sand and gravel, stone, peat, clays
Lycoming.........	W	W	Stone, sand and gravel, coal, tripoli
Mifflin..........	W	W	Sand and gravel, stone, lime
Monroe...........	869	W	Stone, sand and gravel, clays, peat
Montgomery.......	W	W	Stone, cement, lime, clays
Montour..........	W	W	Stone, lime
Northampton......	60,824	63,992	Cement, stone, sand and gravel
Northumberland...	W	W	Coal, clays, stone
Perry............	W	W	Stone
Philadelphia.....	---	W	Sand and gravel
Pike.............	---	---	
Potter...........	107	93	Stone
Schuylkill.......	41,241	W	Coal, stone, sand and gravel, clays
Snyder...........	398	W	Sand and gravel, stone, coal
Sullivan.........	160	964	Coal
Susquehanna......	W	606	Stone
Tioga............	W	W	Coal, sand and gravel
Union............	W	W	Stone, clays
Wayne............	632	W	Stone, sand and gravel, peat
Wyoming..........	1,322	W	Sand and gravel
York.............	4/10,226	W	Cement, stone, lime, clays, sand and gravel, mica
Undistributed5/..	243,839	399,949	
Delaware			
Kent.............	W	W	Sand and gravel
New Castle.......	1,588	1,087	Sand and gravel, clays
Sussex...........	W	W	Sand and gravel
Undistributed2/..	499	527	

TABLE H-2

Value of Mineral Production in North Atlantic Region, by counties (continued)

(thousand dollars)

State and County	1969	1970	Minerals produced in 1970 in order of value
Maryland			
Allegany.........	$ 2,520	W	Coal, stone, sand and gravel
Anne Arundel.....	2,595	$ 3,312	Sand and gravel
Baltimore........	W	15,407	Stone, sand and gravel, clays
Calvert..........	W	W	Greensand marl, sand and gravel
Caroline.........	W	25	Sand and gravel
Carroll..........	W	W	Cement, stone, clays
Cecil............	6,333	6,774	Stone, sand and gravel
Charles..........	W	W	Sand and gravel
Dorchester.......	91	91	Do.
Frederick........	9,867	9,043	Cement, stone, clays, lime
Garrett..........	4,589	6,657	Coal, stone, natural gas, peat
Harford..........	1,489	2,302	Stone, sand and gravel, clays, talc
Howard...........	W	W	Stone
Kent.............	63	W	Clays, peat
Montgomery.......	W	W	Stone
Prince Georges...	8,477	8,790	Sand and gravel, clays
Queen Annes......	---	---	
St. Marys........	W	W	Sand and gravel
Somerset.........	W	W	Do.
Talbot...........	31	W	Do.
Washington.......	W	W	Cement, stone, clays, potassium salts
Wicomico.........	W	W	Sand and gravel
Worcester........	6	13	Do.
Undistributed1/..	47,422	35,802	
Virginia			
Accomack.........	22	W	Sand and gravel
Albemarle........	W	W	Stone, sand and gravel
Alleghany........	W	W	Do.
Amelia...........	---	---	
Amherst..........	W	W	Titanium concentrate, sand and gravel
Appomattox.......	75	30	Stone
Arlington........	---	---	
Augusta..........	952	868	Stone, sand and gravel
Bath.............	1	6/	Sand and gravel
Botetourt........	W	W	Cement, stone, clays

TABLE H-2

Value of Mineral Production in North Atlantic Region, by counties
(continued)

(thousand dollars)

State and County	1969	1970	Minerals produced in 1970 in order of value
Virginia (continued)			
Buckingham.......	$ 4,501	W	Kyanite, stone
Caroline.........	213	W	Sand and gravel
Charles City.....	W	W	Do.
Chesapeake (City).........	W	W	Cement
Chesterfield.....	3,162	$ 3,619	Sand and gravel, stone, clays
Clarke...........	W	W	Stone
Craig............	W	W	Do.
Culpeper.........	W	W	Do.
Cumberland.......	---	---	
Essex............	---	---	
Fairfax..........	5,381	W	Stone, sand and gravel
Fauquier.........	W	W	Stone
Fluvanna.........	W	---	
Frederick........	5,537	5,504	Stone, lime, sand and gravel, clays
Gloucester.......	---	---	
Goochland........	2,404	1,767	Stone
Greene...........	---	---	
Hampton (City)...	W	7	Sand and gravel, stone
Hanover..........	W	W	Aplite, stone
Henrico..........	3,367	3,059	Sand and gravel
Highland.........	W	16	Stone, sand and gravel
Isle of Wight....	223	202	Sand and gravel, lime, stone
James City.......	---	---	
King and Queen...	---	---	
King George......	W	W	Sand and gravel
King William.....	W	W	Do.
Lancaster........	---	---	
Loudoun..........	4,569	3,991	Stone
Louisa...........	W	W	Do.
Madison..........	W	W	Do.
Mathews..........	---	---	
Middlesex........	W	W	Sand and gravel
Nelson...........	W	W	Stone, aplite
New Kent.........	W	W	Sand and gravel
Newport News (City).........	W	W	Do.
Northampton......	5	W	Do.
Northumberland...	8	---	

TABLE H-2

Value of Mineral Production in North Atlantic Region, by counties
(continued)

(thousand dollars)

State and County	1969	1970	Minerals produced in 1970 in order of value
Virginia (continued)			
Nottoway.........	W	W	Stone
Orange...........	W	W	Clays
Page.............	W	W	Stone, sand and gravel
Powhatan.........	---	---	
Prince Edward....	W	W	Kyanite, stone
Prince George....	W	W	Sand and gravel
Prince William...	W	W	Stone, clays
Rappahannock.....	W	W	Stone
Richmond.........	---	---	
Rockbridge.......	$ 901	$ 823	Stone, sand and gravel, clays
Rockingham.......	1,529	W	Stone, sand and gravel
Shenandoah.......	W	W	Lime, stone
Spotsylvania.....	W	W	Sand and gravel, stone
Stafford.........	W	460	Sand and gravel
Surry............	---	---	
Warren...........	W	W	Cement, stone, sand and gravel
Westmoreland.....	W	---	
York.............	W	W	Sand and gravel, stone
Undistributed[1]..	44,801	59,317	
West Virginia			
Berkeley.........	W	W	Cement, stone, lime, clays
Grant............	11,706	W	Coal, stone
Hampshire........	---	---	
Hardy............	35	43	Stone
Jefferson........	W	W	Stone, lime
Mineral..........	W	W	Coal, stone
Morgan...........	W	W	Sand and gravel
Pendleton........	W	W	Stone, lime
Undistributed[1]..	32,263	48,176	
Total North Atlantic Region..	1,209,103	1,294,900	

W Withheld to avoid disclosing individual company confidential data; included with "Undistributed."

r Revised.

1/ Includes value of gem stones and sand and gravel that cannot be assigned to specific counties, and values indicated by symbol W.

TABLE H-2

Value of Mineral Production in North Atlantic Region, by counties
(continued)

2/ Includes value of gem stones that cannot be assigned to specific counties, and values indicated by symbol W.

3/ Includes value of natural gas and sand and gravel that cannot be assigned to specific counties, some salt in peripheral counties, and values indicated by symbol W.

4/ Excludes cement and lime; included with "Undistributed."

5/ Includes value of natural gas that cannot be assigned to specific counties, some bituminous coal in peripheral counties, and values indicated by symbol W.

6/ Less than 1/2 unit.

7/ Includes values indicated by symbol W.

Although the use of synthetic or substitute materials may grow, production of mineral commodities will increase between now and the year 2020. The anticipated annual increase in the Gross National Product (GNP) is 3.8 percent, about twice as great as the expected future growth of population, 1.55 percent. Future annual growth of the mineral industry, as in the past, is expected to be less than that of the GNP. 1/

In NAR the rate of growth for the mineral industry is expected to be less than that for the United States as a whole. The mineral industry's labor force in the Region has decreased in recent years, but prospects are good for a slight increase if presently known mineral resources are developed and new deposits are found.

NONMETALS

Continuing highway, industrial, commercial, and residential construction caused by our expanding economy will result in increasing demand for nonmetallic minerals such as cement, lime, clay, crushed stone, and sand and gravel. Various Federal, State, and private construction programs will continue to consume large quantities of sand and gravel and crushed stone for aggregates and cement. With the spread of population around large metropolitan areas, some parts of NAR may experience shortages of desirable aggregate material. Demand for construction materials will increase and areas of production will shift due to depletion of resources and increasing urbanization. Needs will be supplied by more costly alternate material such as stone sand where adequate sand and gravel deposits are unavailable. Within the next 50 years an important source of sand and gravel as well as other materials may be the Continental Shelf along the Atlantic Seaboard. Aggregate production is expected to more than double by the year 2020. Industrial growth nationally as well as in the Region will expand markets for salt, feldspar, talc, and other nonmetallic minerals as well as cement and lime. However, regional production of some nonmetals such as feldspar, pyrite, and kyanite may not keep pace with the national economy. These minerals could be affected by substitute or synthetic materials and alternate sources of supply. The principal markets for feldspar are in the glass, pottery, and enamel industries but to a substantial degree aplite and nepheline syenite are being used as substitute materials in these industries.

Large deposits of pyrite and pyrrhotite in Maine, New York, and Virginia have been estimated to contain more than 40 million tons of sulfur. However, only those deposits which can be mined for nickel or copper are likely to be exploited. Frasch sulfur from

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1/ Landsberg, H. H., Natural Resources for U.S. Growth, A Look to the Year 2000, Johns Hopkins Press, 1965, p. 81.

the Gulf States and elemental sulfur recovered from refining crude petroleum in NAR are available at lower cost than sulfur produced from pyrite. Pollution control legislation may result in the recovery of significant quantities of sulfur from stack gases at power plants using sulfur bearing fuels. Therefore, it is unlikely that the large reserves of pyrite and pyrrhotite in the Region will be mined for sulfur alone in the foreseeable future.

Adequate reserves of kyanite are indicated in the Region, but it is anticipated that production will not expand substantially in the future. Kyanite is used in its natural form and as a mullite refractory after conversion by heating, but most mullite now used in the United States is produced synthetically from bauxite.

FUELS

The United States will continue to depend on fossil fuels for energy in the future. Our continuing growth in population and per capita energy requirements will result in greater fuel consumption. Most electric power projections for the United States indicate a doubling demand about every 12 years for the next 50 years. However, there is less agreement on the part to be played by the several fuels that will be used to supply the increasing demand for electric power. Coal production will depend on the availability and cost of oil, natural gas, and nuclear energy. Legal restraints such as limits on sulfur in fuel or the prohibition of strip mining also may affect coal production. Bituminous coal's share of the total energy market is expected to decline because of future nuclear power generation and greater use of oil and natural gas. The use of bituminous coal for power may double in 50 years, while power generating capacity may increase as much as 16 times during the same period.

The outlook is mixed for the production of fuels in NAR. Reserves of anthracite, which is mined only in the Susquehanna and Delaware River Basin portions of Pennsylvania, are adequate, but demand began to decline after 1917 when peak production of 100 million tons was reached. The downward trend continued to the 1970 output of 9.7 million tons. The decline is continuing but production is expected to level off at about 3 million tons per year within 30 years. The decline is attributable chiefly to the high cost of recovering anthracite from deep mines which have been inundated with water from previous workings below the water table. The expense of pumping and neutralizing acid water from underground mines has caused the abandonment of hundreds of mines. Stripping operations also entail high costs because of the terrain and the steeply dipping and folded beds which contain the anthracite reserves.

Reserves of bituminous coal are adequate. However, future development of underground mines will depend on control and/or abatement of acid mine drainage and subsidence; development of strip mines will depend on control of land disturbance, stream pollution, and siltation. The growth of both types of mining may well be affected by existing and future legislation regulating the sulfur content of fuels and the storage and utilization of waste material from mines and preparation plants.

Production of natural gas in NAR has been minor and petroleum recovery has been insignificant. Future development of important reserves of petroleum and natural gas appears unlikely except for possible discoveries at deeper stratigraphic horizons or on the Atlantic Continental Shelf. Numerous geophysical surveys have been conducted offshore, and oil companies have indicated interest in offshore drilling. This potential resource should be evaluated, with due regard for environmental controls.

METALS

The Region has not produced metallic minerals in quantities comparable to some other parts of the Nation even though the large population in the Region affords a good market. The advantage of nearness to the market is offset by other factors such as generally small deposits, low grade of ore, and lack of land available for exploration.

The outlook for the production of metallic minerals in NAR depends on the development of economically attractive reserves. For nonferrous metals, the small number of producers and the lack of information on ore reserves make projections misleading. Nationally, the demand for metals will grow and keep pace with expected increases in population and GNP. Production of iron ore, the principal metallic mineral produced in NAR, is expected to continue at current levels or increase slightly in the future. The steel industry in recent years has found an economic advantage in the use of higher grade imported iron ore, and the importance to the Nation of iron ore production in NAR has diminished.

Zinc production will continue to be an integral part of the Region's mineral economy. The long-term upward trend of zinc consumption in the United States is expected to continue and production from mines currently in operation as well as from anticipated new deposits is expected to maintain the Region's present share of the domestic zinc market.

Demand for copper in the U.S. is expected to increase. Production from promising but undeveloped deposits in New England is expected to increase copper output from NAR.

The average annual rate of increase in the demand for titanium minerals as a source of oxide pigments in the United States from 1950 to 1963 was about 5 percent and the rate is expected to continue.

In recent years, use of titanium metal has been increasing rapidly and demand for the metal will grow at an estimated rate of 10 to 15 percent annually. Further development and expanded mining of titanium deposits in NAR are expected.

The United States has virtually no reserves of direct shipping (high grade) manganese ore, but there are large low-grade reserves in NAR. The world supply of good quality manganese ore is substantial but should foreign supplies no longer be available to the United States, large low-grade deposits in Aroostook County, Maine, might be developed.

Deposits of other metals, including chromite, cobalt, molybdenum, nickel, gold, and silver, in the Region are small or low grade but with improved exploration techniques, additional reserves may be found. It is probable that some of these deposits may be mined within the next 50 years.

CHAPTER 3

RELATION OF MINERAL OPERATIONS TO WATER

A few brief definitions of water terms as used by the Bureau of Mines follows:

New Water--Water introduced from external sources for the first time.

Recirculated Water--Water reused in a mine or plant to conserve new water.

Water Used--New water plus recirculated water.

Consumed Water--Water lost by evaporation or shipped with the product.

Discharged Water--Water that is neither recirculated nor consumed, but released to the environment.

Fresh Water--Water suitable for domestic use.

Saline Water--Water containing 1000 parts per million or more of dissolved solids.

Contaminated (Polluted) Water--Water that is unsuitable for domestic use.

WATER USE

The Bureau of Mines water use canvass for 1962 showed that the United States mineral industry used water for mining, 6 percent; processing, 64 percent; cooling and condensing for electric power, 3 percent; other cooling and condensing, 24 percent; and miscellaneous, 3 percent. This percentage breakdown can be applied to NAR because water use is governed by the need rather than the location of a river basin.

Mining itself requires little water per ton of crude ore, except when hydraulicking is used. Water is used in percussion drilling mainly for dust control and in diamond drilling to cool and lubricate the diamond bit and to remove cuttings from the hole. Water also is used to cool compressors and internal combustion engines, and to condense moisture from compressed air before it is piped to the drills and other equipment powered by air.

Most mineral commodities must be processed to separate waste from the product. Beneficiation accounts for most of the water used by the mineral industry. The principal beneficiation processes for which water is used are grinding, washing, froth flotation, gravity separation, sizing, and leaching. Discharged water is usually released into a tailings pond or series of ponds after reagents used in processing have been neutralized. Flocculants may be added to promote settling of fine solids. Mineral processing plants also use water for cooling and condensing.

WATER QUALITY REQUIREMENTS

Most water used by the mineral industry in NAR is from surface sources (streams and lakes); the remainder is from groundwater sources (wells and springs). Some water is pumped from mine openings, which in a sense are large "dug wells." However, unlike natural groundwater which generally is fresh in the Region, mine water is likely to be saline or otherwise polluted. Surface water is fresh in some places, but polluted in others. Common causes of pollution are discharge of chemical waste from industrial plants, sewage from municipalities, and acid drainage from coal mines in parts of Basins 15, 17, and 19.

Water for condensing, cooling, or boiler feed must be of the same quality as is required for similar uses by any industry. Water for mining (drilling) must be free of suspended solids. Other quality factors are desirable but not necessary.

The water quality required for mineral beneficiation plants depends upon the processes used. Most processing plants provide for settling, if the new water contains suspended solids. In the case of plants for processing sand and gravel, coal, and stone, only excessive suspended solids would be troublesome. Mineral processing plants using flotation or chemical treatment must adjust the pH of new water if it is not naturally suitable. Dissolved solids may be a problem if they precipitate when the pH is adjusted. Treatment of new water by precipitation (and disposal) of dissolved solids would add to the cost of the operation.

QUANTITY OF WATER USED

The quantity of raw material treated and the processes used determine the quantity of water required for mineral production. The water required is not the same as the water used, if the supply of water is limited, waste is carefully controlled and recirculation is at a maximum.

An operation using a wet beneficiation process might be able to operate under optimum conditions of water economy and recirculation with less than 350 gallons of new water per ton of mill feed. The same plant might require more than three times as much new water without recirculation and careful use of water. An extreme in reported new water use would be a suction dredge which may take in 8000 or more gallons of new water per ton of raw material. Water use practices which in the past were adopted solely on the basis of lowest cost are being revised to satisfy environmental needs.

Water used by the mineral industry in NAR was estimated to be 164 billion gallons in 1964, compared to 150 billion in 1962. It is estimated that by 1980 water use will be 250 billion gallons and by 2020 about 500 billion gallons will be used, but most of this will be recirculated water. Due to inadequate knowledge of the probable life of active mines, statistical projections for the water needed for production of metals and many of the nonmetals in NAR would be misleading. Projected demand for new water was calculated from past production of commercial sand and gravel and coal (Table H-3).

The quantity of new water taken was about 27 percent of water used by the United States mineral industry in 1962. This ratio is expected to decrease as the cost of water rises. More stringent regulations governing the quality of discharged water will encourage mineral producers to reduce the quantity of discharged water by recirculating as much water as possible to minimize treatment costs.

Based on total quantity of water used, the most important mineral commodities produced in NAR were sand and gravel, coal, stone, iron ore, and titanium. Most of the larger sand and gravel producers used water. All producers of titanium, garnet, kyanite, wollastonite, and zinc used water, but the total quantity used was small because the quantity of ore treated was relatively small.

The quantity of water used per dollar of product value varied with each commodity. Aplite and greensand marl used more than 1000 gallons each; titanium, 965 gallons; sand and gravel, 582 gallons; and salt, 507 gallons. Commodities which used 100 to 500 gallons per dollar were crushed stone, kyanite, garnet, iron ore, anthracite, and bituminous coal. Talc, clay, dimension stone, feldspar, and recoverable zinc each used more than 25 but less than 100 gallons per dollar.

In the study of the water requirements and uses in NAR, the mineral-product value of commercial sand and gravel was $1.72 for each 1000 gallons of water used in 1964, and $1.07 per 1000 gallons of new water. For other commodities, the product value per 1000 gallons of water used was: crushed stone, $4.55; dimension stone, $19.61; talc, $16.67; clay, $38.46; feldspar, $12.35; and, salt, $1.97.

TABLE H-3

Estimated New Water Use by the Mineral Industry in the North Atlantic Region

(million gallons per year)

Basin	1960	1980	2000	2020
1	30	50	70	90
2	70	160	230	300
3	60	130	210	280
4	110	120	130	126
5	90	170	260	340
6	370	1,400	2,420	3,440
7	2,100	4,300	6,600	8,800
8	1,500	4,100	6,600	9,100
9	1,930	3,780	5,500	7,180
10	1,350	2,100	2,480	3,570
11	320	700	1,070	1,450
12	1,700	2,870	4,200	5,530
13	3,850	2,490	1,000	----
14	1,450	3,780	5,840	7,880
15	3,680	6,160	8,160	10,200
16	790	2,600	4,380	6,160
17	12,600	8,400	8,500	9,700
18	1,580	3,500	5,080	6,650
19	3,190	8,130	12,970	17,780
20	130	450	720	990
21	1,580	4,520	7,100	9,730
Total 1/	38,500	59,900	83,500	109,300

1/ Rounded

MINERAL INDUSTRY WATER POLLUTION PROBLEMS

The production of minerals, because it disturbs the earth, accelerates natural geologic processes. Accelerated geologic processes caused by mining translate to mineral industry water pollution. Mining may adversely affect water quality by causing rapid siltation and a relatively rapid increase of dissolved solids.

Erosion is a natural geological process which, by various means, loosens and transports earth material from higher elevations to lower areas. All moving water carries as much of the available particulate material as its velocity will allow. The environment is in balance with normal stream flow, but floods frequently cause siltation which blocks streams and adversely affects their characteristics. Surface runnoff which is allowed to scour mine dumps, mill tailings, and ground disturbed by open pit mining can cause siltation which has much the same effect as a small flood. Siltation also can be caused by the discharge of process water containing suspended solids. Another cause of suspended solids is dredging in rivers and bays. Whether the dredging is done to maintain navigation channels or to recover sand and gravel, a plume of turbidity drifts downcurrent from the dredge until the solids settle.

All water in streams, lakes, and the ground contains dissolved solids (hardness) but in most, the quantity and nature of the elements in solution do not make the water unsuitable for plants and fish to exist in a balanced ecological system. Some naturally occurring surface and ground waters are saline, but most are suitable for fresh water flora and fauna. Mining may cause an increase in dissolved solids in water by exposing more rock surface and allowing more contact time. In addition, certain rock types or minerals may make the water acidic (low pH) or basic (high pH). Except for coal, mineral production in NAR does not cause widespread or persistent water pollution problems.

A serious problem has been created by the adverse effect of acid drainage in the coal mining areas in Basins 15, 17, and 19, and for some distance downstream from the mining areas. Most of the coal horizons in NAR contain pyrite. Mining has exposed large areas of pyritic material to water, oxygen, and bacteria which have oxidized the pyrite and caused excessive concentrations of hydrogen ion (acid), iron, and sulfate in the rivers and streams. The main rivers become neutral by natural oxidation and dilution by basic tributaries after flowing beyond the sources of the acid pollution. However, flash floods in the headwater of the West Branch Susquehanna River have flushed large slugs of acid water into the river causing lower river stretches to run acid for several days.

POLLUTION ABATEMENT MEASURES

The best countermeasure to mineral industry water pollution is to preplan operations to prevent pollution. While a mine is active, the affect of unavoidable potential pollution can be controlled or neutralized. Preplanning should include provision for an effective shutdown program designed to prevent the mine and waste piles from becoming a pollution source when the mine is closed down or abandoned. Legislation is necessary to impel the mineral industry to accept the cost of pollution prevention as a normal operating expense.

Diversion of surface water from mine openings and waste piles, an important step in pollution control, is actually good operating procedure because it usually reduces operating costs. Ground water which enters mine workings should be removed as soon as possible to minimize contact time for the formation of acid and for solution of solids. Provision for adequate settling time before water is discharged from mine or mill is important to prevent siltation. Filtration can be used if lack of space or unfavorable topography preclude the use of settling ponds. Chemical treatment of discharged water may be necessary to neutralize dissolved solids, acid, or reagents used in beneficiation.

Most of the existing acid mine drainage pollution in NAR is from abandoned underground mines which were not preplanned to facilitate pollution prevention when operations ceased. As a result, at many abandoned mines it may be necessary to build treatment plants and support their operation for many years. This costly procedure could, in most cases, have been avoided if the mine openings had been preplanned to facilitate sealing when the mine was abandoned.

Acid pollution from strip coal mines is minor as compared to that from underground mines, and abatement measures present fewer technical problems. Formation of acid and rapid erosion can be prevented by diverting surface runoff, covering the sulfide bearing formations in the high-wall, and grading the area to eliminate ponding of water in depressions behind the spoil banks. In strip mining, siltation can be minimized by reclaiming disturbed land as stripping progresses. Existing laws, if enforced, are generally adequate to prevent new strip mining operations from becoming sources of pollution.

Pollution from abandoned underground mines can be abated most economically by sealing mine openings and preventing the inflow of surface water. Diversion of surface water and sealing of mine openings are the abatement measures most commonly used at present, especially in Pennsylvania. However, a multiplicity of openings, narrow outcrop pillars, and other conditions at many abandoned mines may make sealing ineffective. In such an instance, a plant must be built to neutralize the mine effluent. Active mines prevent the discharge of acid water, in most cases, by neutralization. A number of methods for treating acid mine water are available or under investigation. A brief description of most of these methods follows:

Alkali Neutralization is the method most commonly used to treat acid mine water before it is discharged. This method involves the addition of lime which produces calcium sulfate and iron hydroxide. Aeration and agitation promote precipitation of the calcium sulfate and iron hydroxide; the neutral water is discharged and the precipitate is disposed as waste.

Limestone Neutralization is being used to treat acid mine water. The process uses 400 mesh limestone produced by autogenous grinding of crushed limestone in a tube mill. Fine limestone slurry from the mill is mixed with mine water, aerated, sparged with air, and passed through a sedimentation pond. This system uses low cost ground limestone instead of lime and the sludge is more dense than that produced by the lime process.

Ozone Oxidation is a variation of the lime neutralization process. Ozone is a powerful oxidizer which speeds the oxidation of ferrous iron to ferric iron. Ozone is mixed with air and bubbled through the mine water, converting most of the iron to the ferric state. Neutralization then causes precipitation of ferric hydroxide which is more dense and easier to handle than the ferrous-ferric hydroxide mixture produced by the alkali neutralization process.

Flash Distillation has long been used as a manufacturing process by the chemical industry and is one of the processes being tested for recovering potable water from brackish and saline sources. The process has been tested and found to be effective in treating acid mine water. The feed (mine water) is heated to the vaporization point in a closed chamber and put through a series of condensers at successively lower pressures and temperatures.

Reverse Osmosis has been used successfully in tests to separate fresh water from acid mine water. By applying pressure to acid mine water on one side of a semipermeable membrane, water molecules are caused to move through the membrane leaving behind the iron salts and acid. A use for the residual sludge has not been found.

Ion Exchange process for the treatment of acid mine water consists of the reaction of metal salts and hydroxides in water with specific anionic and cationic resins. One process which is applicable to acid mine water employs a weak base anion resin which is operated in the bicarbonate cycle. The process takes advantage of the fact that almost all of the soluble anions in typical acid mine water are metal sulfates. The metal sulfates are converted to bicarbonates which are precipitated by aeration as insoluble hydrous oxides. As in other acid mine drainage abatement processes, sludge disposal is a problem. The volume of sludge produced by the ion exchange process is substantially less than that produced by the lime neutralization process.

None of the known pollution potentials need become a problem. New operations can be preplanned to avoid or minimize pollution. Siltation and discharge of suspended solids can be prevented by providing for adequate settling area, addition of flocculants, and, if necessary, filtration. Discharge of dissolved solids other than those already in groundwater can be minimized by preventing surface runoff from entering the mine workings. Oil and brine spills are usually the result of inadequate preparation of storage areas. In NAR, most coal measures contain pyrite and most base metal deposits have sulfide ore. Water, oxygen, and bacteria act on the sulfide minerals to produce acid drainage. Acid formed while a mine is active should be neutralized by the operator before release. Underground mines which are a potential source of acid pollution should be so planned that they can be sealed effectively when operations are discontinued. Strip coal mines should be backfilled to cover the sulfur source and graded to drain without ponding. Many responsible mine operators take precautions to prevent pollution on their own initiative, but adequate protection of the environment will require regulation. Water quality standards have been established and approved for all States and most, if not all, of the States in NAR have set up agencies to enforce regulations designed to improve or maintain water quality to meet the standards.

CHAPTER 4

MINERAL RESOURCES IN THE NORTH ATLANTIC REGION

Minerals in NAR are divided into three main classifications--nonmetals, fuels, and metals, in decreasing order of value. The locations and uses of mineral commodities are described briefly for each with emphasis on those commodities for which large quantities of water are used for mining or processing. The location and use of minerals requiring little or no water also are described briefly because this information may be of use to planners.

NONMETALS

The following commodities require a large quantity of water per unit of production:

APLITE

Production and use. Aplite is produced only in Virginia in Basin 20 near Montpelier, Hanover County, and in Basin 21 near Piney River, Nelson County. Aplite is used in glass and ceramics as a source of alumina.

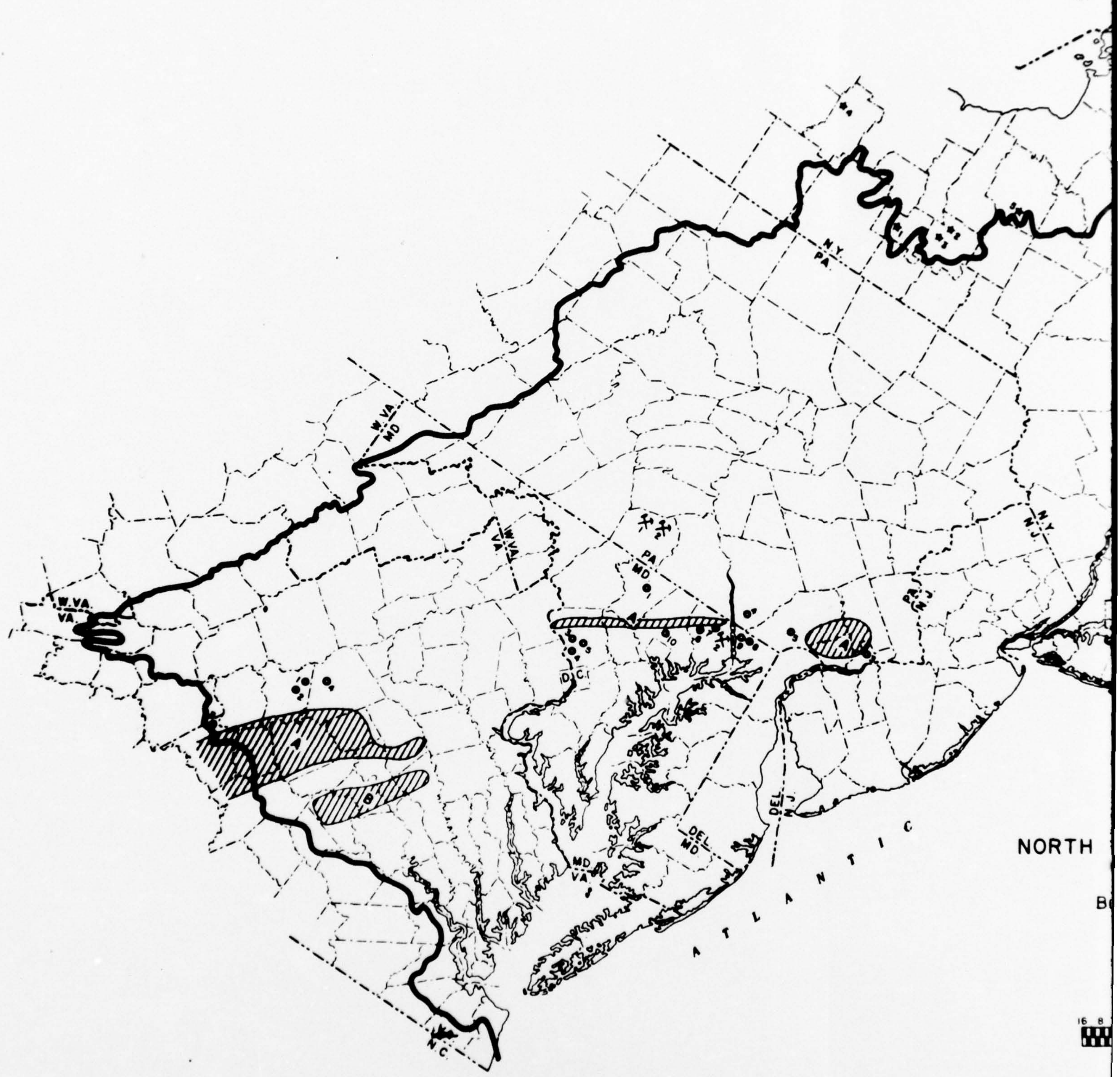
Relationship to water. In 1964, more than 800 million gallons of water was used to process the crude ore but about 90 percent was recirculated. Water was discharged into a tailings pond where particulate matter settled out.

Outlook. Aplite competes successfully with other feldspathic materials used in the manufacture of glass and ceramics. Continued slow growth of aplite production can be expected with no adverse effect on water.

FELDSPAR

Production and use. Almost 96,000 short tons of ground feldspar valued at more than $800,000 were produced in Maine, New Hampshire, Connecticut, and Virginia, in 1964. More than half the crude ore was treated wet and beneficiated by flotation. Silica sand for glass and ground mica for roofing were recovered as byproducts. A decreasing portion of feldspar output has been prepared by dry grinding of selectively mined or handsorted pegmatite rock.

Bodies of pegmatite, a coarse-grained granitic rock, occurring along or parallel to the Appalachian Mountain chain have been the source of most commercial feldspar in NAR (fig. H-2). Production has been reported from groups of pegmatites in 13 of the 21 basins. In New England, pegmatites occur in Basins 3, 4, 5, 6,

C
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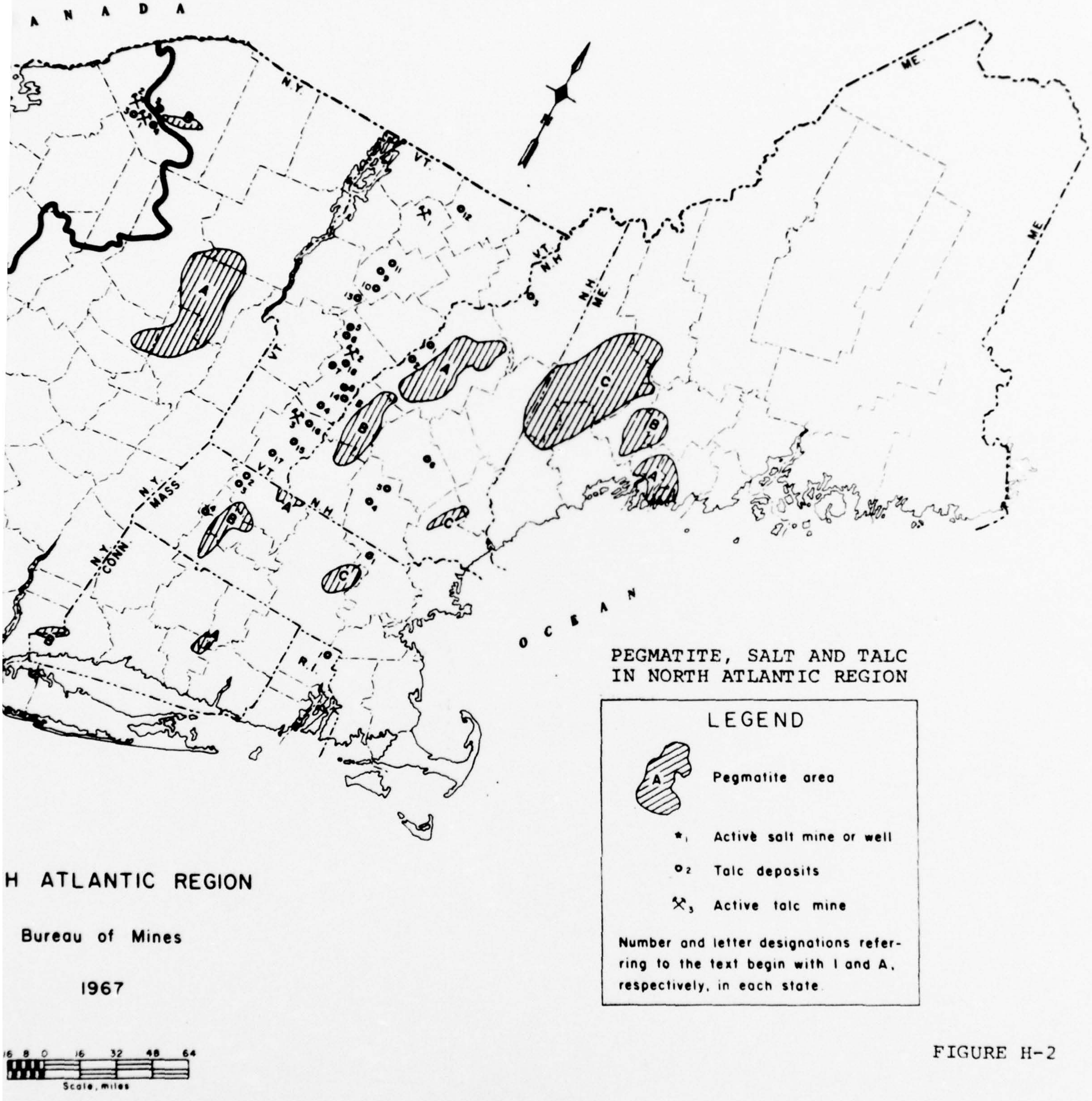

PEGMATITE, SALT AND TALC
IN NORTH ATLANTIC REGION

FIGURE H-2

7, and 8. Pegmatites are found in New York in Basin 12, in Pennsylvania in Basin 15, and in Maryland and Virginia in Basins 18, 19, 20, and 21.

Relationship to water. More than 500 million gallons of new water was used in 1964 to beneficiate feldspar by flotation in Basin 8. No water was recirculated. All discharged water was filtered to remove suspended solids before being released. The filter cake was trucked to a disposal area.

Outlook. Output of feldspar produced by flotation in NAR is expected to continue to grow at a rate less than that for Gross National Product because of competition by other feldspathic products. Output of dry ground feldspar has been decreasing and all operations in NAR may be discontinued before the year 2000. Militating against profitable production of dry ground feldspar are the depletion of suitable reserves and the high cost of selective mining and handsorting.

GARNET

Production and use. Only one mine in NAR produces abrasive garnet as its principal product and no production figures can be revealed. One wollastonite mine produces garnet as a byproduct.

The major use for garnet is as an abrasive material in such applications as optical lens grinding, plate glass grinding, and lapping of semiconductor materials and metals. Garnet is also used in nonskid floor paint, abrasive papers and cloths, and for sandblasting.

Garnet mines and prospects in NAR are indicated on Figure H-3. The only active garnet operation in the Region is in an area of Basin 12 which includes a number of inactive garnet prospects. Garnet also occurs west of Lake Champlain in Basin 11. Two inactive garnet mines are in Merrimack County, N.H., in Basin 7. Connecticut has two inactive garnet mines in the western part of Basin 10 and one in Basin 8.

Relationship to water. At the single active operation in the Region, garnet is separated from the gangue by jigging, tabling, and magnetic separation. Water supply is sufficient at present, and in case of expanded production, additional water requirements could be met by recirculating more water. In 1964, 50 percent of total water was recirculated; 10 percent was lost by evaporation. Forty percent of the total water used is discharged and carries the waste material to the tailings pond where the waste settles out before the water is disposed of through surface channels.

Outlook. Garnet production in NAR is expected to continue to grow slowly. Water pollution will not become a problem since water is used principally as a transportation medium and as an aid in concentration. Additional settling basins, if needed, may be easily installed. Large reserves and expansion of demand indicate increased output until 1980 and then a leveling off until 2020. Technological development could affect the industry adversely.

GREENSAND

Production and use. The principal deposits of greensand occur in Delaware, Maryland, New Jersey, and Virginia, Basins 14, 15, 16, 18, 19, 20, and 21 (fig. H-4). Greensand has been mined in all these States but at present the only active mine is near Sewell, Gloucester County, N.J.

Greensand is produced in New Jersey by hydraulicking in an open pit. The material is either washed, dried, and bagged to be sold as a soil conditioner or further treated to produce zeolite. For use as a zeolite, the washed greensand is given a stabilizing treatment by passing sodium silicate or aluminum sulphate through beds of greensand. The stabilized greensand is rewashed, then dried and bagged.

Relationship to water. Although production data for greensand in NAR are confidential, the water used in 1964 was estimated to be 65 million gallons of which 30 million gallons was recirculated. The average annual production during the period 1960-64 was 4,000 tons, indicating that about 16,000 gallons of water was used per ton of greensand produced. The quantity of water discharged was approximately the same as the quantity of new water used. The discharged water was not treated.

Outlook. Production of greensand for soil conditioning is limited because of high transportation costs and low market value. Synthetic zeolite water softening agents have replaced the natural zeolites recovered from greensand. Mining of greensand in NAR will probably be discontinued by 1980.

Greensand has been a minor source of potash in the past and may be of future importance only if extraction of potash can be done cheaply enough to compete with other potash sources. The deposits that could be mined by open pit in New Jersey are estimated to contain more than 250 million short tons of potash in material that averages 6.6 percent potash.

KYANITE

Production and use. Kyanite is an aluminum silicate mineral identical in composition and most uses with andalusite and sillimanite, but differing from them in crystal form. This highly refractory mineral is mined by open pit methods from large deposits of kyanite-bearing quartzite rock containing 10 to 30 percent crystalline kyanite. The kyanite is concentrated by flotation.


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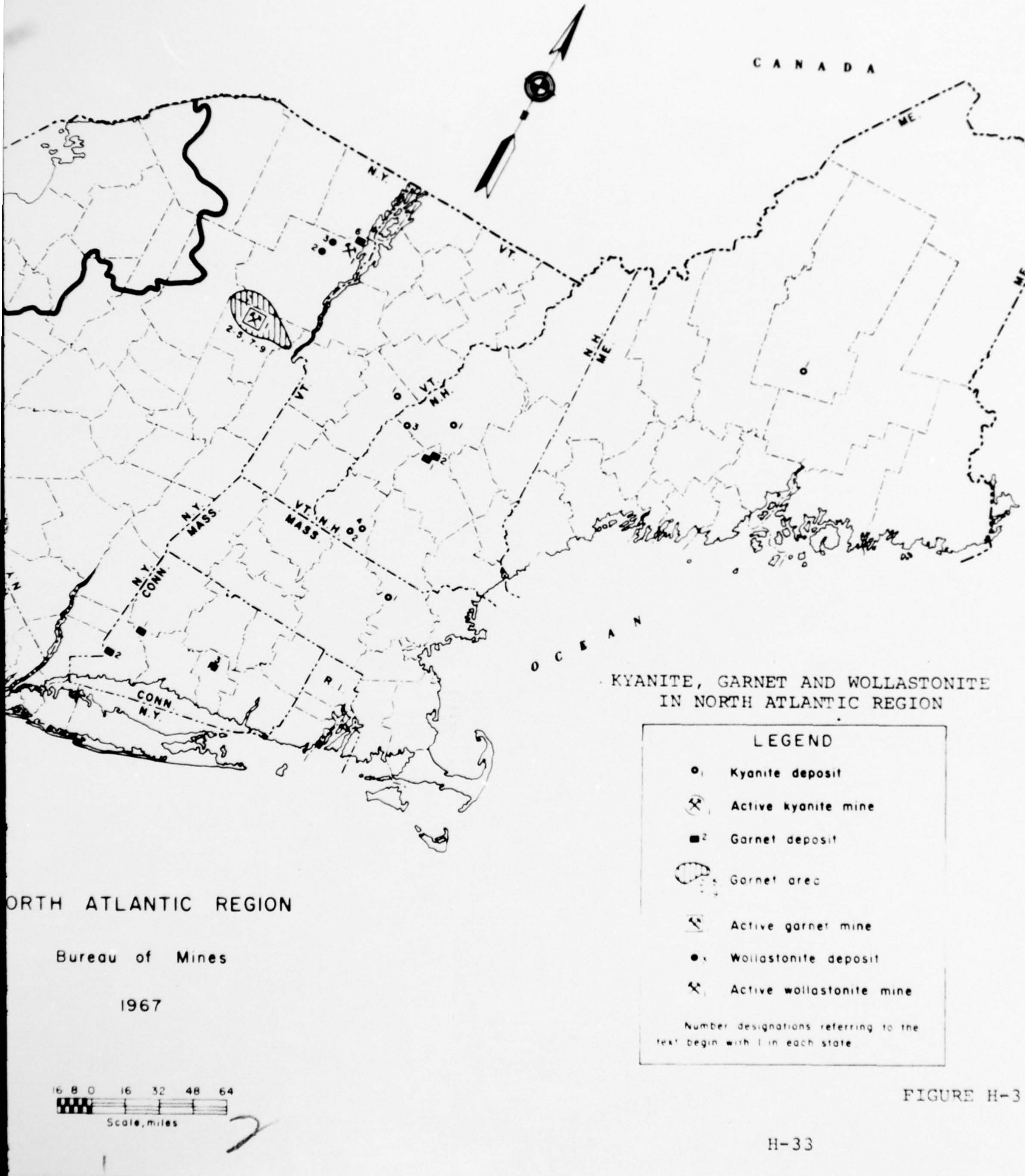
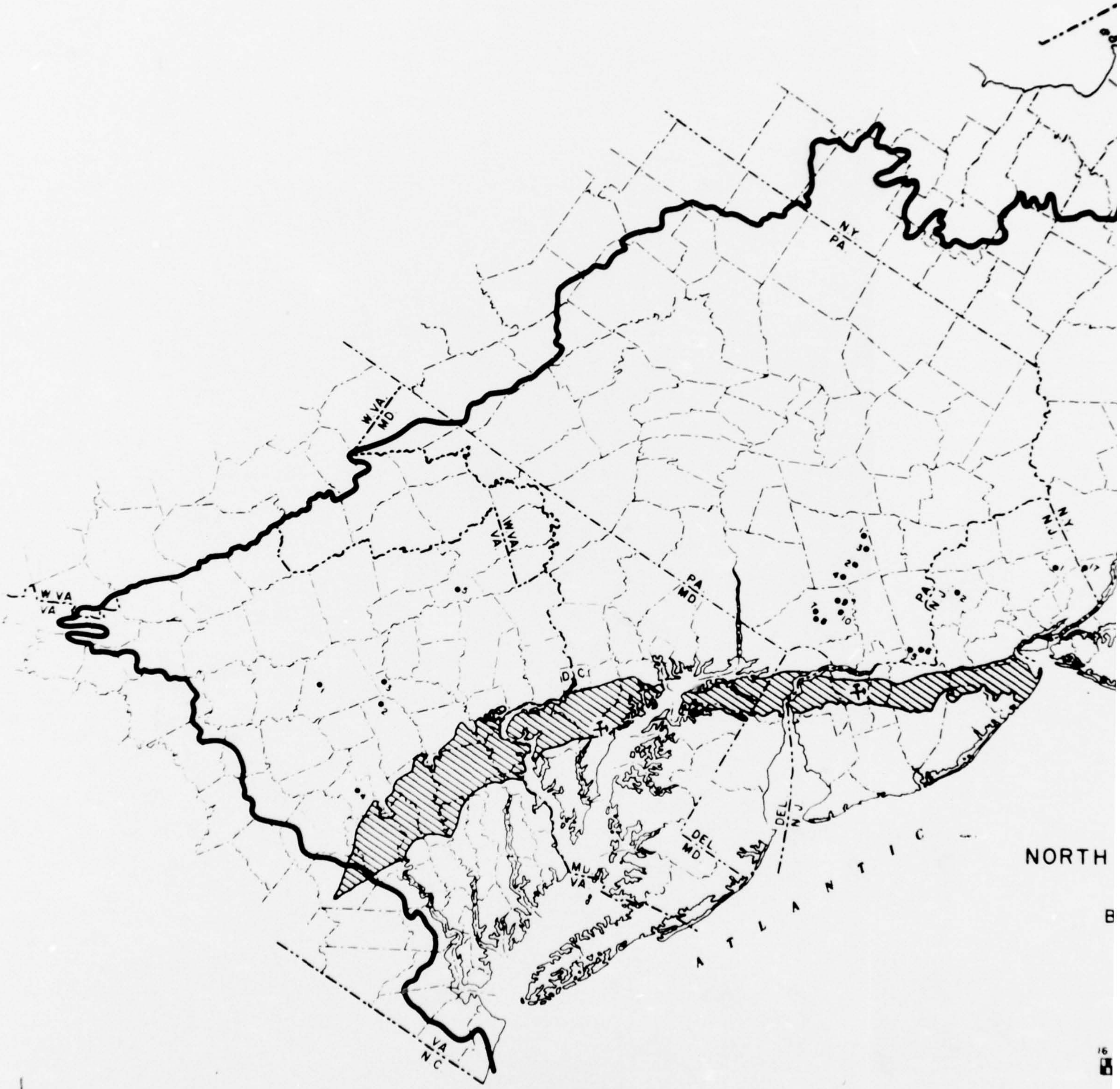


KYANITE, GARNET AND WOLLASTONITE IN NORTH ATLANTIC REGION

FIGURE H-3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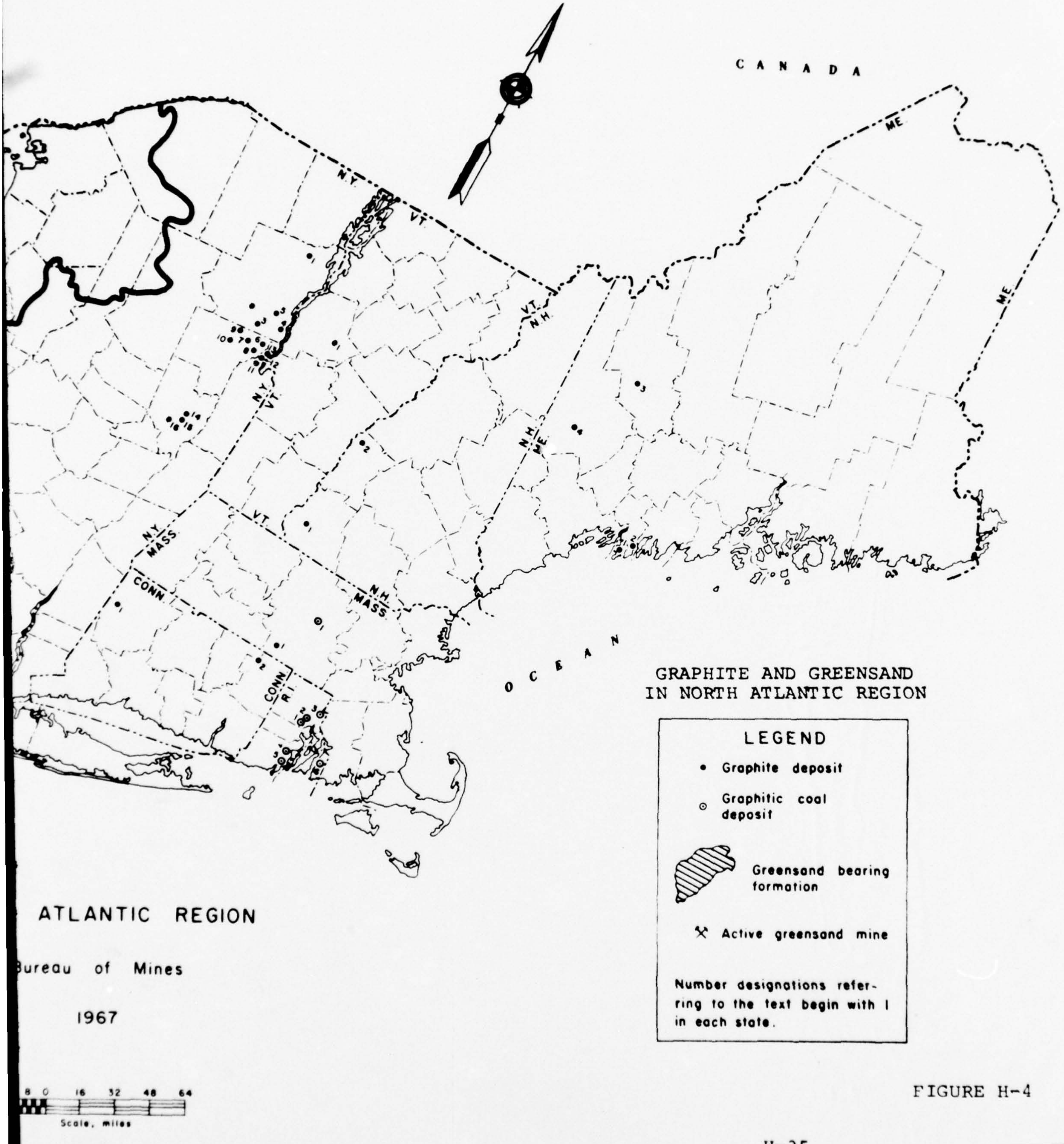
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GRAPHITE AND GREENSAND
IN NORTH ATLANTIC REGION
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● Graphite deposit
⊙ Graphitic coal deposit
▨ Greensand bearing formation
⚒ Active greensand mine
Number designations referring to the text begin with 1 in each state.
ATLANTIC REGION
ureau of Mines
1967
8 0 16 32 48 64
Scale, miles

FIGURE H-4

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Kyanite concentrate is used in ceramic mixes to obtain volume and stability of fired products, as expansion of kyanite on conversion to mullite in the mix compensates for shrinkage of other components. Kyanite concentrate is also converted directly to mullite by heating at about 1500°C. The mullite is used in the manufacture of refractories, including brick and shapes, mortars, plasters, and ramming mixes. Production data cannot be revealed but domestic consumption of kyanite and synthetic mullite in 1964 was estimated to be more than 100,000 tons.

Kyanite is produced at two mines in Virginia (Basin 21); one at Willis Mountain, Buckingham County, and the other at Baker Mountain, Prince Edward County (fig. H-3). The ore is processed at mills adjacent to the mines and at plants at Dillwyn and Pamplin City. Besides the two active mines, other occurrences are found in Buckingham and Prince Edward Counties as well as in the Anna River pegmatite area, which includes portions of Caroline, Hanover, Louisa, and Spotsylvania Counties (Basin 20). Other occurrences in Virginia are outside NAR. Andalusite occurs in Piscataquis County, Me. (Basin 2), and Middlesex and Worcester Counties, Mass. (Basin 7). Kyanite is found in Vermont (Basin 7) and both sillimanite and kyanite in Basins 7 and 8 in Grafton and Cheshire Counties, N.H.

Relationship to water. In 1964, the two milling operations in Virginia used an average of 11,000 gallons of water for each ton of concentrate produced. The mill in Buckingham County recirculated 87 percent of the total water used, discharged 10 percent, and consumed the balance. The Prince Edward County mill recirculated no water, discharged 90 percent, and consumed 10 percent.

The quality of water used in preliminary grinding is not as important as that used and recirculated in the flotation process, where it is necessary to treat the water by controlling acidity and by settling. The water supply is sufficient for the present. However, at one mill most of the available water is now being used along with maximum recirculation, and any additional requirements will have to be obtained fron new wells or other surface sources. Water is discharged to a tailings pond where suspended solids settle out.

Outlook. Usage of kyanite is expected to increase about 9 percent a year until 1985 when it will begin to level off. By the year 2020, much of the kyanite used will be synthetically produced.

SALT

Production and use. The salt-bearing Salina Formation extends under part of Basin 17 in New York and Pennsylvania (fig. H-2). Producing areas peripheral to NAR in New York State affect the economy of the Region and salt production from Tompkins, Onondaga, Livingston, and Schuyler Counties is included in Table H-1. Besides food processing and seasoning, large quantities of salt are used in chemical processes and manufacturing. Increasing quantities of salt are used for ice and snow control on roads.

Relationship to water. Water is not used in underground salt mining. Water used in solution mining of salt is evaporated, or the brine is used in chemical processing plants.

Outlook. Salt production is expected to continue to increase. The Saline Formation dips southeast and is deeper in NAR than in the producing areas to the west. There is little likelihood that new operations will be established during the 20th century in areas where the salt is deeper than in areas currently mined.

SAND AND GRAVEL

Production and use. Sand and gravel constitutes one of the North Atlantic Region's principal resources, with the total volume of production exceeding that of any other mineral commodity with the exception of stone. Production is divided into two classes: Commercial, in which the products are sold on the open market; and, noncommercial or government-and-contractor, in which the product is produced exclusively for Federal, State, county, or municipal governments and is used principally for road construction and maintenance.

Deposits are broadly separated into bank, pit, and subaqueous. Bank deposits are usually mined dry although sometimes they are hydraulicked by forcing water under high pressure against a bank and pumping the resulting slurry to the processing plant. Pits are mined either dry or wet, depending on the level of the water table. Subaqueous deposits are those in rivers, lakes, or seas and are usually dredged. Different combinations of excavating equipment are used, including power shovels, bulldozers, front-end loaders, draglines, suction and bucket dredges, and hydraulic monitors.

Quantities of unprocessed bank run sand and gravel are used for fill and road material but the greatest part of commercial production is washed, screened, and otherwise processed. In most cases the material must be screened to meet size specifications and washed to remove clay, silt, and soil. Material is washed during the screening process and oversize gravel is crushed.

Sand and gravel for concrete aggregate must meet rigid specifications. Sand is separated from gravel by screening and the clay is removed by classifiers or scrubbers. Gravel is freed from deleterious material by crushing, screening, and washing. The cleaned sand and gravel is then further screened and classified to meet commercial specifications. The amount of treatment used in preparing the sand and gravel for market will be greatly influenced by the physical characteristics of the material in the deposit and by the market for which it is intended.

Transportation costs of sand and gravel are high relative to its low unit value and the bulky nature of the product. Commercial operations are usually set up near a source of water supply and near the point of use.

Production of sand and gravel in NAR in 1964 was nearly 131 million tons or 15 percent of the total United States output. Although production of sand and gravel has been reported from every State in NAR and active or latent deposits are known in almost every county, not all areas in the Region are equally supplied. Since the construction industry utilizes most of the sand and gravel, the volume is closely tied to local construction and population centers. Because of the relatively large number and types of deposits, it would be impracticable to describe in detail either the deposits or the individual operations. Areas of production in 1964, by counties and magnitude, are shown in Figure H-5.

In the southern part of NAR, beyond the limits of glacial activity, most of the sand and gravel deposits are in unconsolidated Coastal Plain sediments, beach sands, and river and stream deposits.

Most of the commercial sand and gravel in the northern part of NAR is the result of glacial disintegration and abrasion of bedrock. Upon recession of glacial ice this material was deposited, then transported, further abraded, and sorted by running water. Major valleys occupied by the glaciers were the principal areas of deposition of this sorted sand and gravel. Outwash areas which are the best sources of sand and gravel in the Region are shown in Figure H-6.

Many commercial sand deposits are residual, formed by the weathering of sedimentary and igneous rocks. High-silica sandstone beds most often mined for industrial sand also are outlined in Figure H-6.

Relationship to water. Sand and gravel was the largest user of new water and the third largest in total water used among the mineral commodities in the United States mineral industry in 1962. The total water use and reuse are dependent on the quantity of material treated and the process water requirements of each particular mineral commodity.

In 1964, 80.7 million tons, or 62 percent of the total sand and gravel produced in NAR, required water for mining or processing. Total water used was 62,239 million gallons or 770 gallons for each ton of finished product. No water was reported in noncommercial production.

Water requirements of sand and gravel operations vary with the method of mining, which in turn depends on the type of deposit, end use of the product, and proximity to the surface of the ground water level.

Process water for sand and gravel should be free of suspended solids and dissolved solids such as sulfates which would adversely affect the quality of concrete. Water having a high or low pH can cause deterioration of processing equipment. In ocean or bayside pits, salt films may coat the sand grains and the sand must be washed with fresh water to be acceptable for some purposes. However, according to recent studies in Great Britain, sodium chloride acts as a mild accelerator in concrete when present in concentrations of 0.5 to 1.0 percent by weight. Less than 1.0 percent of sodium chloride is not a threat except for steel reinforced concrete for which sodium chloride limits should be set.

Water pollution by the sand and gravel industry consists chiefly of siltation caused by solids in the waste water. In most cases the suspended material can be removed by settling in ponds before the water is returned to the drainage system. The ponds are dredged as required and the material sold for fill and special applications.

Outlook. The construction industry utilizes 96 percent of the commercial sand and gravel production and is mainly responsible for the annual increase in tonnage and value. The continuing increase in population with resulting construction work, plus the national roadbuilding program will increase the demand for sand and gravel. Because of its bulk and low unit value, transportation is a large factor in the economics of the industry. With the population expansion, mainly in metropolitan areas, many deposits in or near these areas will be either worked out or unavailable because of zoning restrictions; supplies will have to be obtained from greater distances at higher cost. Deposits of sand and gravel are seldom surveyed in depth to determine reserves but as a generality it may be stated that resources of sand and gravel are sufficient to meet the demand created by any foreseeable expansion in the national economy. Good sand and gravel is not available in quantity in all areas and not all marginal deposits can supply satisfactory aggregates. Substitute materials, such as crushed stone, will probably supply most needs of the future where sand and gravel is not available.

Water requirements for the Nation's mineral industry are expected to increase and the requirements for the sand and gravel industry can be expected to follow this trend. An adequate quantity and quality of water must be provided or developed at the place and time it is needed to mine and process sand and gravel to meet increasing future needs. At the present time, 86 percent of commercial sand and gravel production is processed. This percentage is expected to increase. Continued depletion of high-grade deposits near urban centers may accelerate the trend toward more washing because producers will be forced to use lower grade deposits to maintain production within the economic shipping distance of consumers. With the increased demand for washed aggregate, the problem of obtaining adequate supplies of wash water will be intensified and the problem of waste water disposal will become more critical. In the


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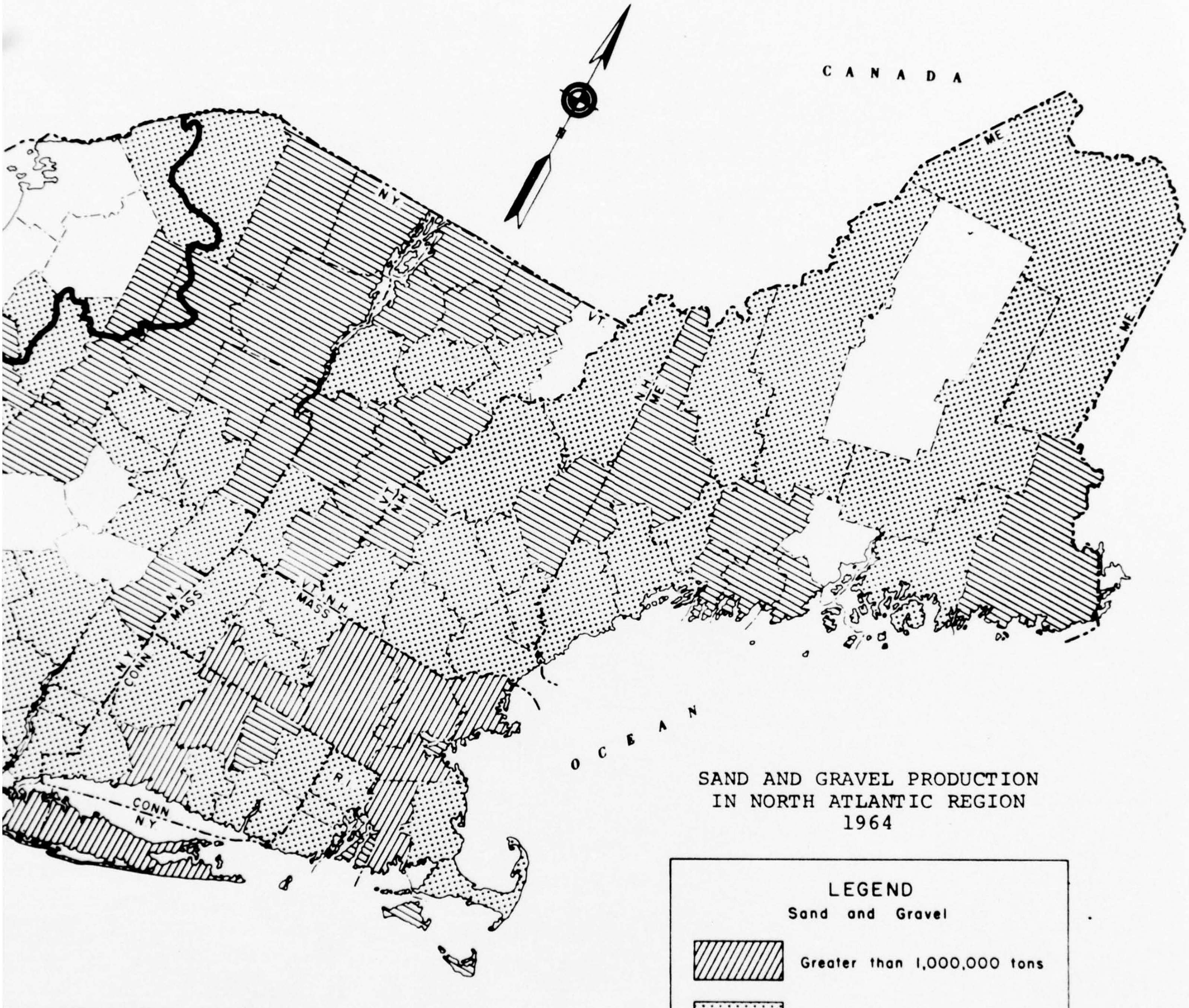

SAND AND GRAVEL PRODUCTION
IN NORTH ATLANTIC REGION
1964

LEGEND

Sand and Gravel

- ▨ Greater than 1,000,000 tons
- ░ 100,000 - 1,000,000 tons
- ▧ Less than 100,000 tons
- ☐ No production

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Bureau of Mines

1967

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Scale, miles

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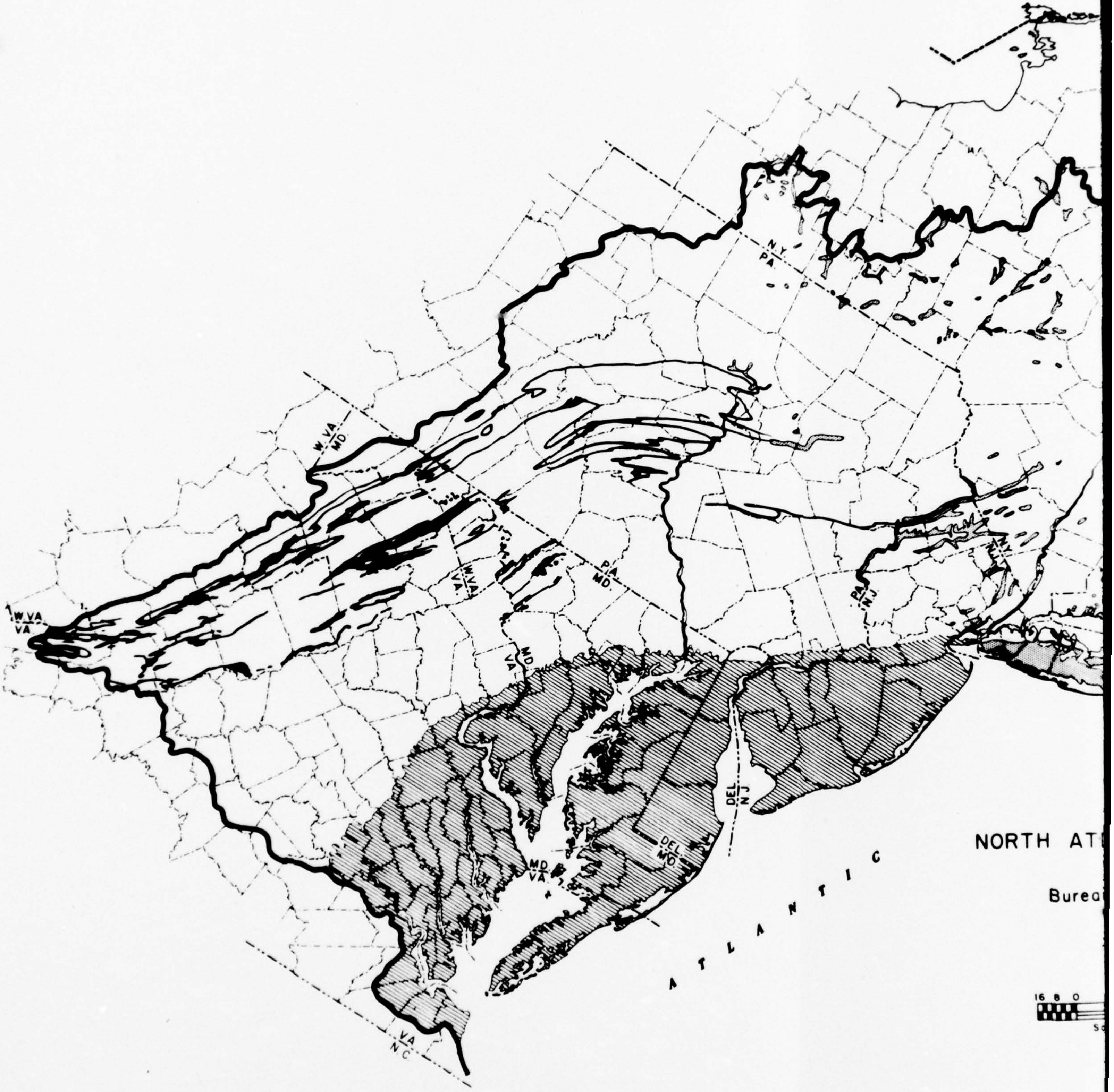
FIGURE H-5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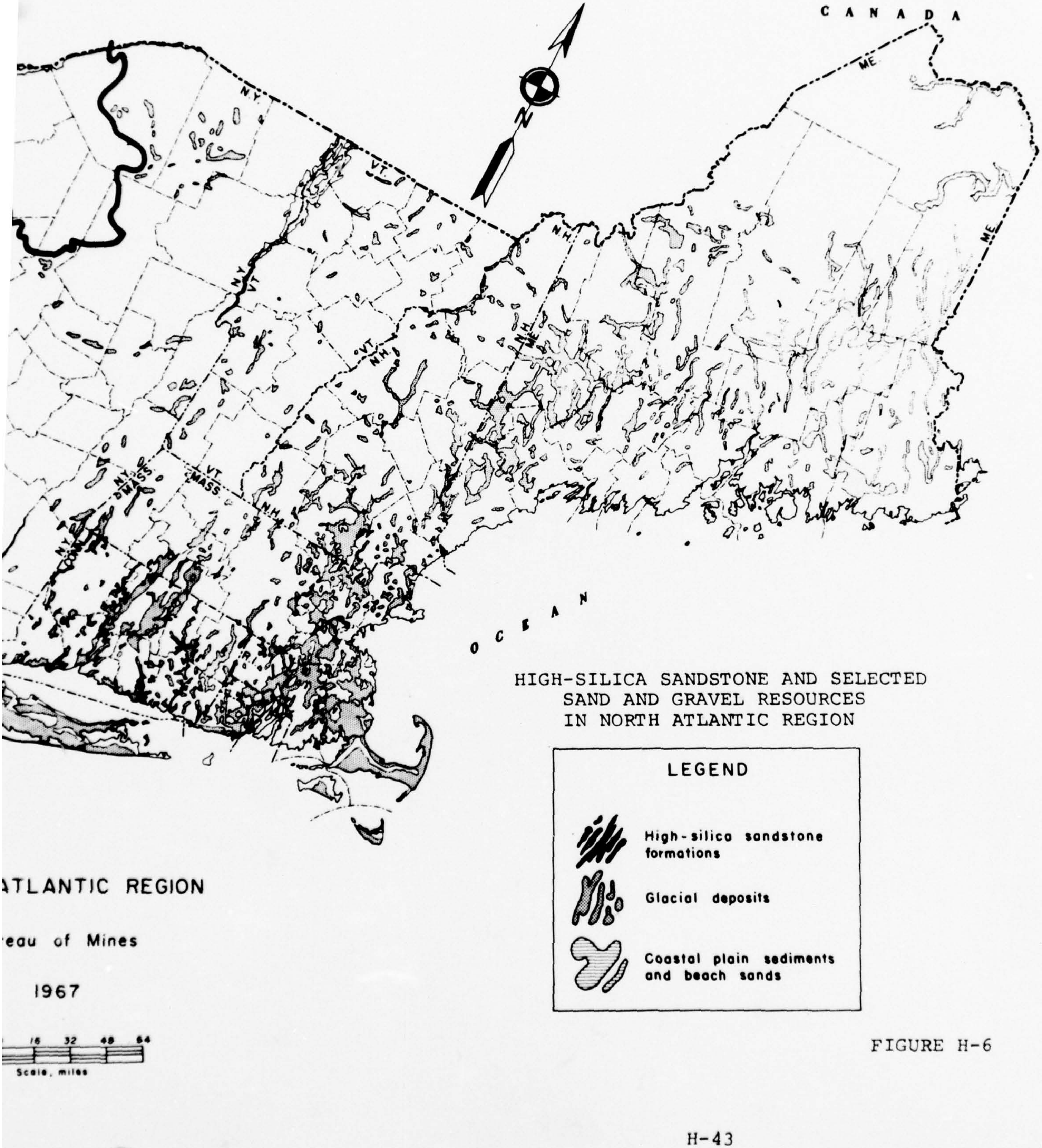

HIGH-SILICA SANDSTONE AND SELECTED SAND AND GRAVEL RESOURCES IN NORTH ATLANTIC REGION

FIGURE H-6

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future, zoning restrictions and State water regulations may require all producers to treat waste water in settling ponds.

STONE (Crushed)

Production and use. Stone is the principal mineral resource of NAR. Crushed stone production in NAR in 1964 was 142.9 million tons valued at $243.7 million, 20 percent of the total United States production and 24 percent of its value. Crushed stone was produced in 177 of the 271 counties in NAR in 1964 as indicated in Figure H-7. Forty-six counties had production of over 1 million tons; 25 counties, 500,000 to 1 million tons; 62 counties, 100,000 to 500,000 tons; and the remaining 44 counties, less than 100,000 tons. There were over 200 producers of limestone (including dolomite), 81 producers of basalt or traprock, and 34 producers of granite; the remainder were producers of sandstone, quartz, quartzite, marble, schist, and other stone.

Thirty-two percent of the crushed stone of all categories was produced in the Pennsylvania portion of NAR; New York accounted for 20 percent; Virginia, 16 percent; New Jersey and Maryland, 9 percent each; Massachusetts and Connecticut, 4 percent each; West Virginia, 3 percent; and Maine, Delaware, New Hampshire, Vermont, and Rhode Island together produced the remaining 3 percent.

Stone deposits are found in every State in NAR, and it would be impractical to describe in detail either the individual operations or deposits. Some of the known deposits are remote and relatively inaccessible so that production is uneconomical at present.

Crushed stone is a heavy, high-bulk, low unit value commodity, and its economic utility in a particular area is restricted by its ability to compete on a delivered price basis with stone from other sources. Accessibility and cost of transportation often determine whether or not a particular deposit is a commercial reserve.

Limestone is the most important rock used for crushed stone in NAR and is quarried chiefly in West Virginia, Virginia, Pennsylvania, Maryland, and New York. Some metamorphosed limestone or semimarble is mined and crushed in the New England States, Maryland, New York, and Virginia.

Traprock (diabase or basalt), the second ranking stone in NAR, is quarried extensively in Connecticut, New Jersey, Pennsylvania, and in portions of Maryland, New York, and Virginia.

Granite, which is crushed and used chiefly for aggregates, is found in widely scattered areas. The greatest production comes from deposits in the mountainous areas of the New England States where granite is common.

Other types of stone are found throughout the Region and are important locally. Miscellaneous rocks found in NAR but important only locally include gneiss, quartzite, sandstone, marble, argillite, and soapstone. Crushed stone is produced from these rocks when satisfactory deposits are near sites of immediate temporary need or when the cost of shipping other types of stone is prohibitive.

Limestone was the leading type of crushed stone produced in the United States in 1964 accounting for 71 percent of the total, which also approximates the percentage of limestone supplied by NAR. Limestone has a wide variety of uses, more than any other type of rock. Large quantities are used for manufacturing cement and lime, furnace flux, agricultural stone, and in numerous chemical and industrial applications. Most types of rock are used for concrete aggregate and roadstone, but limestone is especially favored for this purpose. Stone reserves in NAR are large, but stone of the quality required to meet specifications for a particular use are limited in some areas.

Relationship to water. Water requirements of the crushed stone industry are generally greater for processing than for mining. Water use in mining is limited to dust control during drilling, loading, and transporting.

The extent of processing is governed by the use for which the crushed product is required. Most stone applications require adherence to rigid specifications, i.e., concrete and road aggregates must be crushed, cleaned, and graded to specific sizes; pulverized stone is frequently used in processes requiring fineness of more than 65 percent passing 200 mesh. Most stone is crushed and screened dry, but cleaning requires water. Owing to the low prices of crushed stone, dry grinding is preferred to the wet method and occasionally the stone is artificially dried to assure better grinding. Classification normally employs screens of various types. The larger fragments are sized with bar grizzlies and perforated steel plate. When the fine sizes are used, they are classified by screening or air separation.

Use of water by the crushed stone industry has become more general in recent years to control dust and to meet stricter specifications. A common wash method is to use water jets for spraying the stone during screening. Some crushed stone may require additional scrubbing to remove adhering coatings. The quality of water need not be high, but the water should be free of suspended or floating solids, particularly organic, which may cause contamination of the crushed stone with subsequent weakening and discoloration if used in concrete. The water also should not contain a high percentage of acid or alkaline impurities which would cause corrosion of the washing, screening, and crushing equipment.


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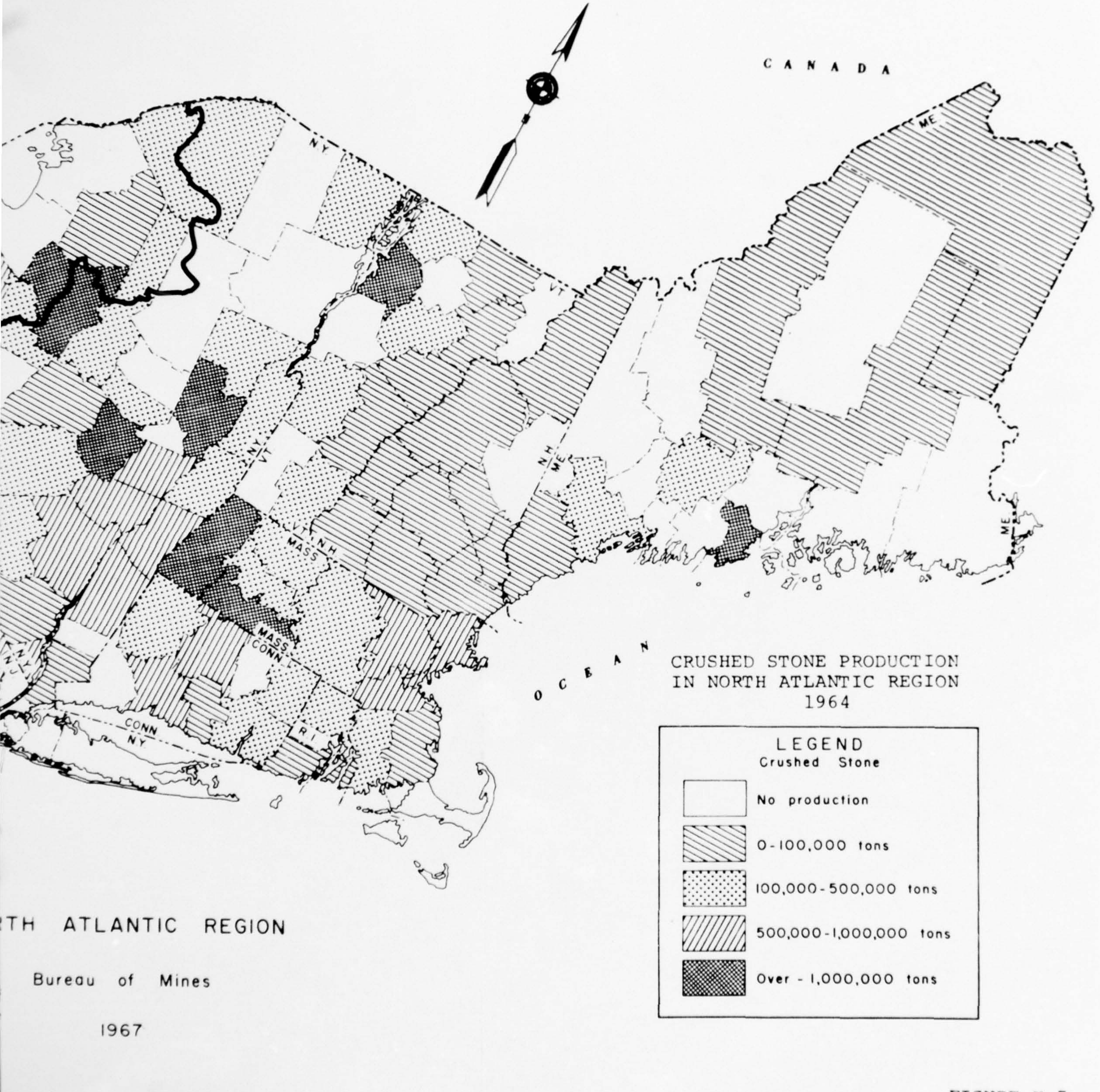

CRUSHED STONE PRODUCTION
IN NORTH ATLANTIC REGION
1964

FIGURE H-7

In 1964, water was used in the production of about 63 million tons or 44 percent of the crushed stone produced in NAR and required a ratio of 375 gallons to each ton of finished product.

Outlook. It is estimated that about 60 percent of the crushed stone produced in NAR is used for construction and that the quantity of stone produced for this purpose will continue to show an annual increase. Increased production will be required because of long range construction programs and greater use of crushed stone sand in areas where sand and gravel is depleted or zoned out. The largest single use for crushed stone is for aggregates and it is expected that aggregate production will more than double by the year 2020.

STONE (Dimension)

Production and use. Stone which can be cut to a definite shape and size from quarried blocks or slabs is classed as dimension stone. The principal types of dimension stone produced in NAR are granite, marble, sandstone, and slate. Other dimension stone produced include basalt, schist, and other miscellaneous stone.

In 1964, 179 companies produced 734,000 tons valued at $37.3 million. Dimension stone is produced in every State of the Region except Delaware. In some areas it is a major industry. Vermont and Massachusetts were the leading areas for granite production. Dimension marble was produced in Vermont and Maryland.

Dimension stone is classed into two main categories, rough and dressed. Both types are produced in NAR and quarrying and preparation varies with each stone type and its end use. Rough dimension stone is used chiefly in construction. Most of the dimension stone produced in NAR is dressed for use as monumental stone, curbing, flagging, and in architectural applications. In NAR, granite is used principally for curbing, monuments, and architectural applications; marble and sandstone for various architectural uses, and slate for flagstone.

In quarrying dimension stone, considerable skill is needed to break loose large blocks in the quarry without fracturing or producing excessive quantities of waste rock. Channeling machines and wire saws are used for cutting dimension stone in the quarry. Drilling and wedging equipment is also used extensively. In recent years, an oxygen-kerosene jet flame for cutting in granite quarries has found wide use. The medium used for cutting by wire saws is a slurry of water and sand for softer stones and silicon carbide or aluminum oxide for granites and some marble.

Dimension stone is usually prepared at adjacent mills using equipment similar to that used in the woodworking industry, except that saws are set with diamond teeth and other operations use silicon carbide grinding wheels.

Preparation for market varies with different types of stone and their end uses. The stone is cut into blocks by circular, gang, or wire saws. Some stones are smoothed by planers; polishing is generally done by rubbing beds, rotating heads, and polishing pads. Carving and shaping is done by hand, abrasive blasting, and jet flame. Slate is split by hand and may be shaped either by hand or by machine.

Rock masses or formations of various types of stone and which are of potential commercial quality are numerous in NAR. The localities or quarries where the principal types of dimension stone were produced in 1964 (Fig. H-8) are as follows:

Granite. In Basin 5 in Maine, one quarry was active in each of Hancock, Knox, and Waldo Counties. Other quarries worked intermittently are near North Jay, Franklin County (Basin 3), and near Wells and York, York County (Basin 6). Dimension granite was produced at quarries in Merrimack and Hillsboro Counties, N.H. (Basin 7); other quarries are worked intermittently. Inactive quarries are found in Carroll County (Basin 6). Most of Vermont's dimension granite output is from Washington County (Basin 11). Quarries also are active in Orange and Windsor Counties (Basin 8). Dimension granite quarries in Massachusetts are operated in Middlesex (Basin 7), Norfolk and Worcester Counties (Basin 9), and Berkshire County (Basin 8); other quarries are worked intermittently.

Dimension granite was quarried in Connecticut in four counties, mainly for architectural and monumental purposes. Quarries are in Basin 8, Hartford County; Basin 9, Windham and New London Counties; and Basin 10, New Haven County. Two quarries were active in Washington County, R.I. (Basin 9). Granite quarries in New York are located in Essex (Basin 11) and Westchester Counties (Basin 12). In Basin 15, active granite quarries are in the Philadelphia metropolitan area. Dimension granite is quarried near Port Deposit, Md. (Basin 17) and dimension diabase is produced in Culpeper County, Va. (Basin 20).

Marble. Dimension marble is produced principally in Rutland County, Vt. (Basin 11). Other quarries in the State are in Grand Isle and Windsor Counties. Dimension marble also is produced in Harford County, Md. (Basin 17).

Sandstone. In Connecticut, dimension sandstone is quarried principally in Windham County (Basin 10). In Basin 8, sandstone is produced in Hampden County, Mass. Sandstone suitable for dimension is quarried chiefly in Delaware and Broome Counties, N.Y. (Basin 15). Other quarries are in Franklin (Basin 11), Albany (Basin 12), and Otsego Counties (Basin 17).

The principal dimension sandstone quarries in Pennsylvania are in Susquehanna County (Basin 17). Other quarries are in Basin 15, Wayne, Bucks, and Delaware Counties; and in Basin 17, Potter County. Sandstone quarries are in Faquier and Stafford Counties, Va. (Basin 19).

Slate. Dimension slate is recovered from an underground mine in Piscataquis County, Me. (Basin 2). The Washington County, N.Y., and Rutland County, Vt., slate area in Basin 11 is the largest slate-producing area in the United States. Thirty-two quarries, 20 in Vermont and 12 in New York, were active in 1964. In Pennsylvania, slate production is centered in Northampton and Lehigh Counties (Basin 15). Slate in Virginia is quarried in Buckingham County (Basin 21).

In Figure H-8, limestone and miscellaneous stone quarries are indicated. Miscellaneous stone includes schist, basalt, and greenstone. Quarries producing these latter stones are not numerous but may be of economic importance locally.

Relationship to water. Relatively little water is used in the production of dimension stone because many producers recirculate water. One company in Massachusetts used about 100 gallons of water to produce 1 ton of granite. Another company in Vermont used nearly 3,000 gallons per ton for the same type of stone. Dimension granite producers in Connecticut, Maine, Maryland, and New Hampshire did not report the use of water. Therefore, it is difficult to predict the quantity of water needed to produce dimension granite. Water used in the marble industry ranges up to 56,000 gallons per ton. However, no comparison should be made since in 1964 there was production in only four counties in two States. Three operations reported using no water. Slate producers reporting water usage showed a range from 63 gallons per ton to nearly 3,000 gallons per ton. Most sandstone producers reported using no water but one indicated use of 4,000 gallons per ton of product.

Outlook. Dimension stone competes with newer building materials such as glass, plastics, and metals. The old advantage of high compressive strength no longer applies in modern building construction. Expansion of this industry will depend on utilization of higher weather resistance and natural beauty as a building material and keeping costs competitive with the newer materials. Some dimension stone production may increase because of specialized uses such as precast building panels veneered with natural dimension stone. However, the long term outlook for any significant increase in demand will require competitive production costs and full utilization of superior physical properties.

Since little water is used by this industry, water pollution is not considered a problem. However, discharges from finishing plants in urban centers may create siltation problems because of lack of space for settling ponds.

TALC

Production and use. Production of talc, including soapstone and sericite schist in NAR in 1964 was 415,000 tons valued at $2.5 million. Most of the output was from two underground mines in St. Lawrence County, N.Y., which are on the periphery of Basin 11. Other producers of talc and talc materials were active in Vermont, Pennsylvania, Virginia, and Maryland (Fig. H-2). A soapstone mine and mill in Carroll County, Md., ceased operation at the end of 1968. Other producers of talc and talc materials were active in Vermont, Pennsylvania, and Maryland. A soapstone mine and mill in Carroll County, Md., ceased operation at the end of 1968.

Talc has a variety of uses each of which has its own set of specifications. Ground talc is used chiefly as a filler material by the ceramic and paint industries. Ground talc is also used in insecticides, roofing, rubber, asphalt, paper, toilet preparations, and other miscellaneous materials.

As indicated in Figure H-2, talc deposits are found in all States except Maine, Connecticut, New Jersey, Delaware, and West Virginia. In Basin 7, deposits are located in Middlesex County, Mass., and Hillsboro and Merrimack Counties, N.H. There are numerous talc deposits in Basin 8, most of which are located in Windsor and Windham Counties, Vt. Other deposits are in Coos and Grafton Counties, N.H., and Franklin and Hampshire Counties, Mass. In Rhode Island, talc occurs in Providence County. Basin 9.

Talc occurrences in Basin 11 are in St. Lawrence County, N.Y., and in Addison, Chittenden, Lamoille, and Orleans Counties, Vt. In Pennsylvania, inactive soapstone mines are located in Philadelphia and Chester Counties (Basin 15) and Lancaster County (Basin 17). Maryland deposits are in Harford (Basin 17), Cecil and Baltimore (Basin 18), and Montgomery Counties (Basin 19). Virginia has talc deposits in Albemarle, Campbell, and Nelson Counties, Basin 21.

Relationship to water. Most of the talc produced in NAR is dry ground and air floated. However, at the Johnson, Vermont, mill (Basin 11), water flotation is used to produce a better grade product. The Vermont plant does not treat discharge water but pollution is not a problem because all talc is removed and the flotation reagent is harmless. No sulfide minerals are present and mine water is neutral.

Outlook. Nationally, consumption of talc, soapstone, and associated minerals has increased by an average of 20,000 tons annually for the past 20 years. This rate of increase is expected to continue and producers in NAR can be expected to contribute to this growth in the future.


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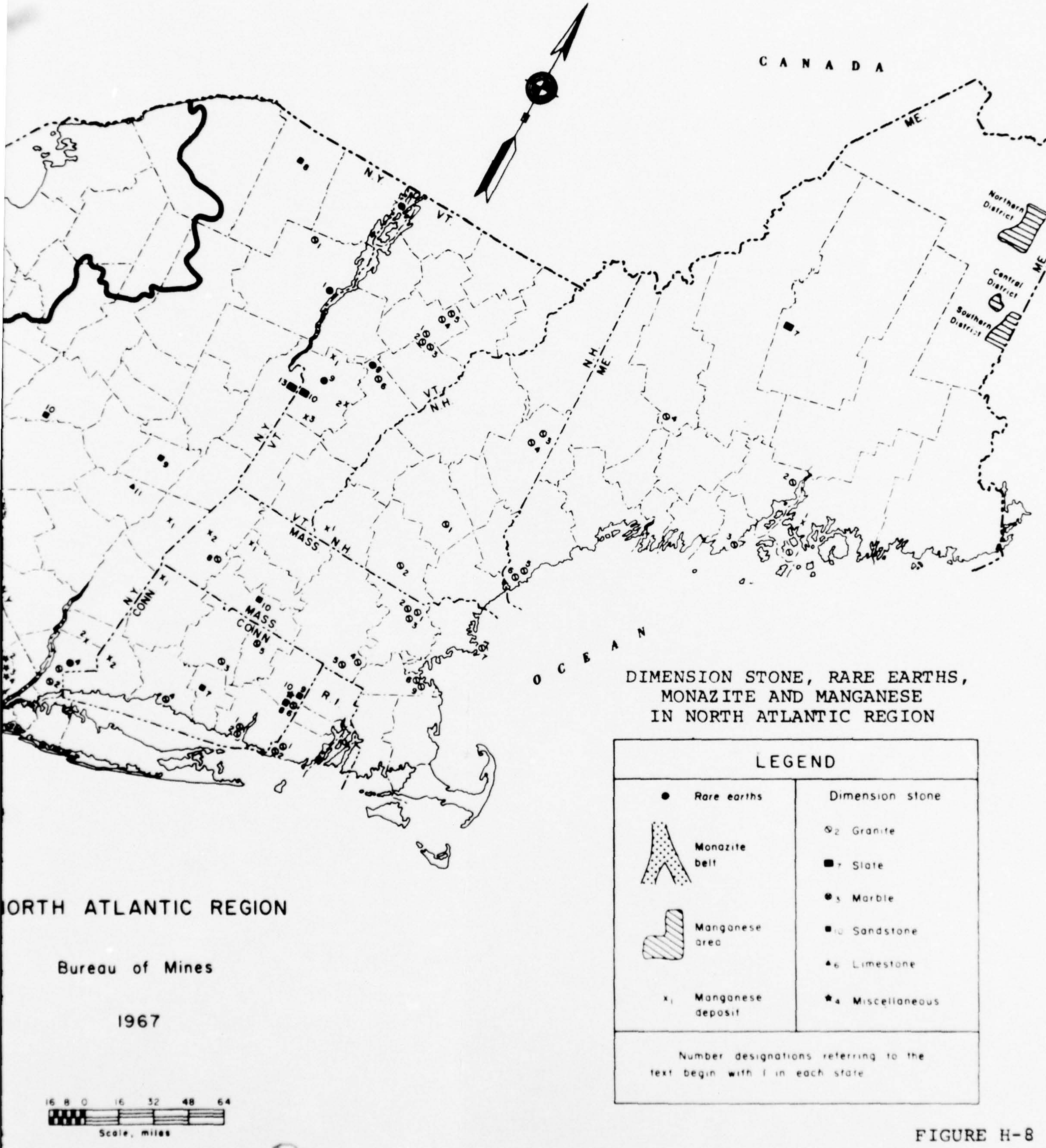

DIMENSION STONE, RARE EARTHS, MONAZITE AND MANGANESE IN NORTH ATLANTIC REGION

FIGURE H-8

The following commodities require little or no water in mining and/or processing:

ASBESTOS

Asbestos is produced at only one mine in NAR, near Lowell, Orleans County, Vt. (Basin 11). Another mine near Eden, Lamoille County, discontinued production in 1943. No water is used in asbestos mining and milling except for drilling. Water from the mine is drained into surface channels but pollution is not evident. Asbestos from the Lowell mine is widely used for asbestos-cement products such as roofing, shingles, siding, pipe insulation, and paper. Rock discarded from the processing mill is used in road construction.

United States annual production of asbestos may increase to 200,000 tons by 1985 compared with domestic production of more than 100,000 tons in 1964. The United States produces only about 10 percent of total consumption and must depend upon imports from Canada and the Union of South Africa for the balance. Canada supplies over 90 percent of these imports.

CEMENT AND LIME

Cement and lime industries are sometimes interrelated since the principal ingredient for production of both is limestone. Although neither industry is water related, they generally are large operations and may affect the mineral economics of the Region.

Cement manufacture requires large quantities of limestone and clay, and smaller amounts of other ingredients including bauxite, gypsum, iron oxide or mill scale, fly ash, and silica. Nearly 3,200 pounds of raw materials are used to produce 1 ton of portland cement. There are several varieties of cement, the standards for which have been established by the American Society for Testing and Materials (ASTM).

The principal type is portland cement, a hydraulic cement consisting of compounds of silica, lime, and alumina. Masonry cement is a mixture of portland or natural cement, finely ground limestone or lime, and a plasticizer. The third type is natural cement which was produced in Ulster County, N.Y.; production ceased in 1967.

Production of cement in NAR in 1964 was nearly 71 million barrels of portland, over 5 million barrels of masonry, and a minor quantity of natural cement. Portland cement is used in concrete construction where compressive strength and durability are the primary requirements. Masonry cement is used in building construction as a finishing cement.

Lime is made in several ways depending upon its final use. Quicklime is produced by heating crushed limestone in a kiln with temperatures high enough to drive off carbon dioxide. Hydrated lime is made by adding water to quicklime and then drying the lime. Lime is used in agriculture, construction, metallurgy, and as a basic industrial chemical. Two industrial uses of significance to pollution control are the neutralization of industrial wastes and in water softening and purification.

Deposits of limestone suitable for cement and lime production are found in all States of NAR except Delaware and New Hampshire. The only cement plant in Maine is at Thomaston, in Basin 5. No primary lime is produced in the State. In Massachusetts, three companies produce lime in Berkshire County; there are no cement producers.

The principal center for cement production in New York is in the Hudson River Valley for the New York and New England market. Cement plants are located in Albany, Greene (three plants), Columbia, Ulster (two plants), Warren, Onondaga, and Schoharie Counties. Lime was produced at a chemical plant in Onondaga County.

More cement and lime are produced in Pennsylvania than in any other State of the North Atlantic Region. The abundance and accessibility of high-grade limestone and other cement raw materials, and extensive nearby markets have led to the high utilization of these resources. Important commercial cement and lime producers are located in the central and southeastern counties. Eight cement plants are located in Northampton County; four in Lehigh County, and one each in Berks, Montgomery, and York Counties. Three lime plants are in Centre County and one each in Chester, Columbia, and York Counties.

In New Jersey, the State's only lime producer is located at Newton, Sussex County.

Three cement plants, one each in Carroll, Frederick, and Washington Counties, are active in Maryland. In Frederick County, three companies burn limestone for lime.

Three cement plants are located in Virginia: one each in Botetourt and Warren Counties and one in Chesapeake City. Lime plants are found in Frederick, Giles, Isle of Wight, Tazewell, and Shenandoah Counties.

In the West Virginia portion of Basin 19, three lime plants, one each in Berkeley, Jefferson, and Pendleton Counties, and one cement plant in Berkeley County are active.

Little water is used in the manufacture of cement in NAR. Some water is used in the lime industry particularly to produce hydrated lime. This water is lost by evaporation and hydration of the lime; little is lost through drainage. The quantity of water used in producing hydrated lime is one part water to approximately three parts quicklime. The quality of water used in the lime industry is not of critical importance, but it must be free of solids, floating or suspended, which may interfere with the production of high grade material.

Increased production of cement is expected in response to population growth and to expanding need in highway, industrial, and housing construction. During 1969, nearly 408 million barrels of all types of cement were produced in the United States. Industry projects cement production in the United States at 740 million barrels by 1980 and about 1750 million barrels by the year 2000. Reserves of raw materials required for cement production are adequate. Growing stream pollution control should increase the market for lime used to reduce acidity and as a coagulant for precipitating industrial wastes.

Over 20.2 million tons of primary lime was sold or used by producers in the United States during 1969, an increase of 4.1 million tons over 1964. Lime production is expected to continue to increase.

CLAY AND SHALE

In NAR, 1964 clay production was more than 6.2 million short tons valued at $16.8 million. Varieties of clay produced in the Region are common or miscellaneous clay (including shale), kaolin, ball clay, and fire clay. Because of the extensive occurrences of miscellaneous clay and shale there are few areas in NAR that do not have some sort of clay industry. Miscellaneous clay and shale is used principally for manufacturing building brick and tile, sewer pipe, terra cotta, lightweight aggregate, and portland cement. Kaolin is used as a coater and filler in the paper industry. It also is used as a filler in rubber, paint, and fertilizer, and in the manufacture of refractories and pottery. Ball clay is used principally in pottery, stoneware, and floor and wall tile. Fire clay is used primary in the manufacture of heavy clay products and refractories.

Some type of clay or shale has been produced in every State of the North Atlantic Region and deposits are so widespread that individual locations are not discussed. During 1964, all States in NAR, except Rhode Island, produced miscellaneous clay. Small quantities of kaolin were produced in Vermont and Pennsylvania; ball clay was produced in Maryland; and fire clay was produced in Maine, Maryland, New Jersey, and Pennsylvania.

Water is used in producing clay and shale products but the quantity is minimal. At clay product plants water is used in mixing operations to make the clay plastic but it is lost in processing through evaporation. Pollution is generally not a problem of the clay industry.

Production of clays and shales in general should continue to increase. Production of some clays such as fire clay will decrease in the future because of depleted reserves and the accelerated use of substitute materials. Kaolin production will continue to expand because of its specialized use.

EMERY

Emery is produced in the United States only in NAR near Peekskill, N.Y. (Basin 12). It is mined from shallow open-cut workings. Emery is used as an abrasive component for grinding wheels and abrasive cloth. However, imported Turkish emery is generally preferred for these uses. Domestic emery is used principally as a nonskid element in pavements and stairways.

Besides the active mines near Peekskill, N.Y., emery deposits are known near Chester, Hampden County, Mass., and near Chatham, Pittsylvania County, Va. Emery also occurs in Pennylvania but the Massachusetts and Virginia deposits are the only ones known to have had production.

No water is used in mining or milling emery and there is no pollution problem. Proved and indicated reserves of emery are adequate for the future.

GRAPHITE

Currently, no graphite is mined or processed in NAR. The major use for natural graphite is for brushes in electrical motors and other electrical equipment, and for clay-graphite crucibles. Most graphite used today is artificially manufactured for electrodes, anodes, and for various shapes used in metallurgical and chemical applications.

In the New England States some small deposits contain enough flake graphite to have been of economic interest in the past. Graphite occurs mostly disseminated in schists and other metamorphic rocks. As indicated in Figure H-4, the principal area of graphite and/or graphitic coal occurrences in New England is in Rhode Island (Basin 9) with six localities.

Most of the graphite deposits in New York occur in the eastern Adirondack Mountain area of Essex, Warren, Washington, and Saratoga Counties. Deposits also occur in St. Lawrence County and in metamorphic rocks of the Highlands region in Rockland County.

The graphite deposits of Pennsylvania are limited to the highly metamorphosed rocks in Berks, Bucks, and Chester Counties. Graphite occurrences are found in Passaic and Hunterdon Counties, N.J.

In Virginia, graphite is known to occur in a number of localities in Albemarle, Louisa, Orange, Powhatan, and Warren Counties.

Development of graphite mines in NAR in the future is unlikely since there is only a limited market for each type of graphite and no indication of increased demand for natural graphite. Most of the graphite in New York or Pennsylvania does not meet specifications for crucible-grade graphite. If mining were resumed at these localities, beneficiation would be by flotation which requires water.

Imported ore of superior quality is priced lower, at point of import, than it could be produced at any potential mine in NAR. Manufactured artificial graphite is of sufficient quality and quantity to meet future requirements.

MAGNESIUM COMPOUNDS

The principal primary magnesium compounds are deadburned dolomite, refractory magnesia, and caustic-calcined magnesia. From these are formed many other magnesian compounds and chemicals.

Refractory magnesia is produced from dolomite and sea water at one plant at Cape May, N.J. (Basin 16). The dolomite is crushed, screened, washed, and then calcined at temperatures ranging from 1000° to 1200°C. to form magnesian lime. The magnesian lime is added to sea water to precipitate magnesium hydroxide, the calcium oxide going into solution as calcium chloride. The magnesium oxide is dewatered and fired in rotary kilns in temperatures as high as 1850°C. The principal uses for magnesium compounds are for flux, refractories, cements, pulp and paper, chemicals, rayon, and many miscellaneous applications. Small quantities of magnesium chloride crystals, magnesium sulfate (epsom salts), magnesium trisilicate, and other high-purity magnesium chemicals also were made in New Jersey.

Sea water is used in producing magnesium compounds, and solutions remaining after removal of minerals are returned to the ocean. No pollution problems are evident in this process. Magnesia production will tend to increase since the refractory industry is expected to require increasing quantities of high-purity magnesium oxide.

POTASSIUM SALTS

Potassium sulfate is produced as a byproduct at a cement plant at Security, Md. (Basin 19). This product is a low grade salt used for agricultural purposes. It is recovered by collecting, in precipitators, ash formed during the burning of cement materials. No water is used in production of these potassium salts. Production of these salts from the cement plant will probably continue. However, production is small and future output will depend chiefly on cement production at the plant.

PYRITE

In NAR pyrite generally occurs with iron, copper, lead, and zinc ores; and in some cases with gold ore. In Pennsylvania, pyrite is a byproduct of iron production at Cornwall, Lebanon County (Basin 17), and Morgantown, Berks County (Basin 15). Recovery of pyrite from the Cornwall mine averaged 100 tons for each 6,500 tons of ore treated. A concentrator at the mine processes the ore by crushing and grinding, magnetic separation, and flotation to produce iron ore, pyrite, and copper concentrates. The principal use for pyrite is in the production of sulfuric acid. The iron oxide byproduct, the residue after sulfur removal, is used in the production of pig iron.

Deposits with iron sulfides as the principal minerals of potential economic importance occur in all States of the North Atlantic Region except Delaware and West Virginia and are indicated in Figure H-9. Some of the deposits have been productive in the past but none are being mined now.

In Maine, 15 or more localities have been noted in Aroostook, Franklin, Knox, Oxford, Piscataquis, Somerset, Washington, and Hancock Counties. Almost all copper, lead, and zinc occurrences in New Hampshire carry pyrite which could be produced as a byproduct. Estimates have been made that the ratio of pyrite to waste in most of these deposits is about 1 to 13. Deposits are known in Coos, Grafton, and Sullivan Counties.

Considerable pyrite and pyrrhotite is known in waste dumps of old mines. The waste dumps of the Vermont Copper Belt are estimated to contain 200,000 tons of iron sulfide minerals. Old mines and prospects are found in Lamoille, Orange, Rutland, and Windsor Counties. In Massachusetts, 10 mines or prospects are known in Berkshire, Essex, Franklin, Hampshire, Middlesex, and Worcester Counties. Connecticut has occurrences in Fairfield and Litchfield Counties.

The iron pyrites in Jefferson and St. Lawrence Counties of New York lie in a northeast trending belt parallel to the St. Lawrence River 4 miles wide and 35 miles long extending from the vicinity of Antwerp to Canton. Nineteen pyritic deposits are known in the Region, most of which lie in this belt. Pyrite occurrences in Pennsylvania are located in Bucks, Berks, Lancaster, Lebanon, and York Counties.

Almost all pyrite found in New Jersey is associated with magnetite deposits in Morris, Sussex, and Warren Counties. Some sulfide minerals have been found in New Castle County, Del., but no deposits are known since a thick mantle of sand and clay covers the bedrock. Pyrite is present in the Sykesville Mine, Carroll County, Md. The principal sulfide deposits in Virginia are chiefly pyrite and pyrrhotite in a northeasterly belt extending through


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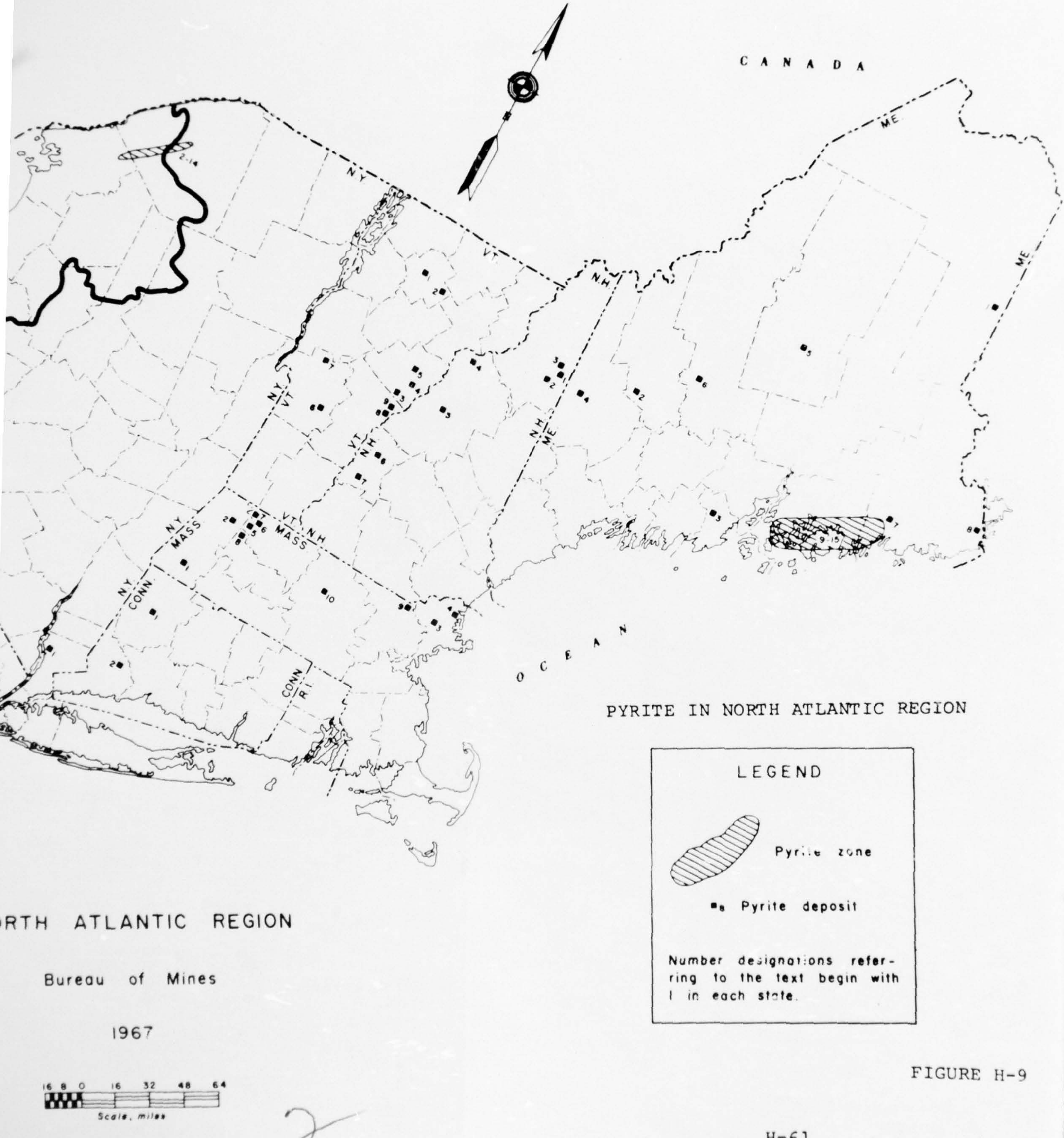


PYRITE IN NORTH ATLANTIC REGION

FIGURE H-9

Basins 19, 20, and 21. The principal deposits in this belt are in Louisa, Prince William, and Stafford Counties.

It is not likely that the pyrite and pyrrhotite deposits in NAR will be mined in the future, but if such mining occurred, the potential for polluting nearby water sources will be greatly increased unless adequate measures are taken to prevent or minimize pollution. The large reserves of pyrites in Maine, New York, and Virginia are estimated to contain over 40 million tons of sulfur. These reserves will probably not be exploited as a source of sulfur mainly because sulfur can be mined more economically by the Frasch method in the Gulf States. In addition, the iron content is not high enough to be considered for development as a primary source of iron. Future production of pyrite will depend chiefly on development of new base metal mines where the pyrite is recovered as a byproduct and the continuing operation of the magnetite mines in Pennsylvania.

TRIPOLI

In NAR tripoli (rottenstone) is produced only in Basin 17 near Antes Fort and Muncy, Lycoming County, Pa. It occurs there as a weathered silicous residue of limestone or black calcareous shale. Rottenstone is mined from open pits. It is then crushed and dried, air floated, and bagged. The final product is used as an abrasive or filter medium. No water is used to mine or process tripoli in Pennsylvania.

Rottenstone is produced in Pennsylvania because the deposits are close to consuming markets. The future of this industry in Pennsylvania depends upon the existence of little known reserves, but it is reasonable to assume that production will continue for some time.

WOLLASTONITE

The only known deposits of wollastonite in the Region are in Essex County, N.Y., in Basin 11 (fig. H-3). One operation is active at Willsboro. Other mines are near Lewis and Clintonville. Principal uses for wollastonite are in the manufacture of ceramics, paint, plastics, and in certain building products.

Water used in mining is negligible, although some water is used to control dust during drilling. Before crushing and concentrating the ore must be thoroughly dry. There are no water pollution problems in this industry, as milling is a dry process.

FUELS

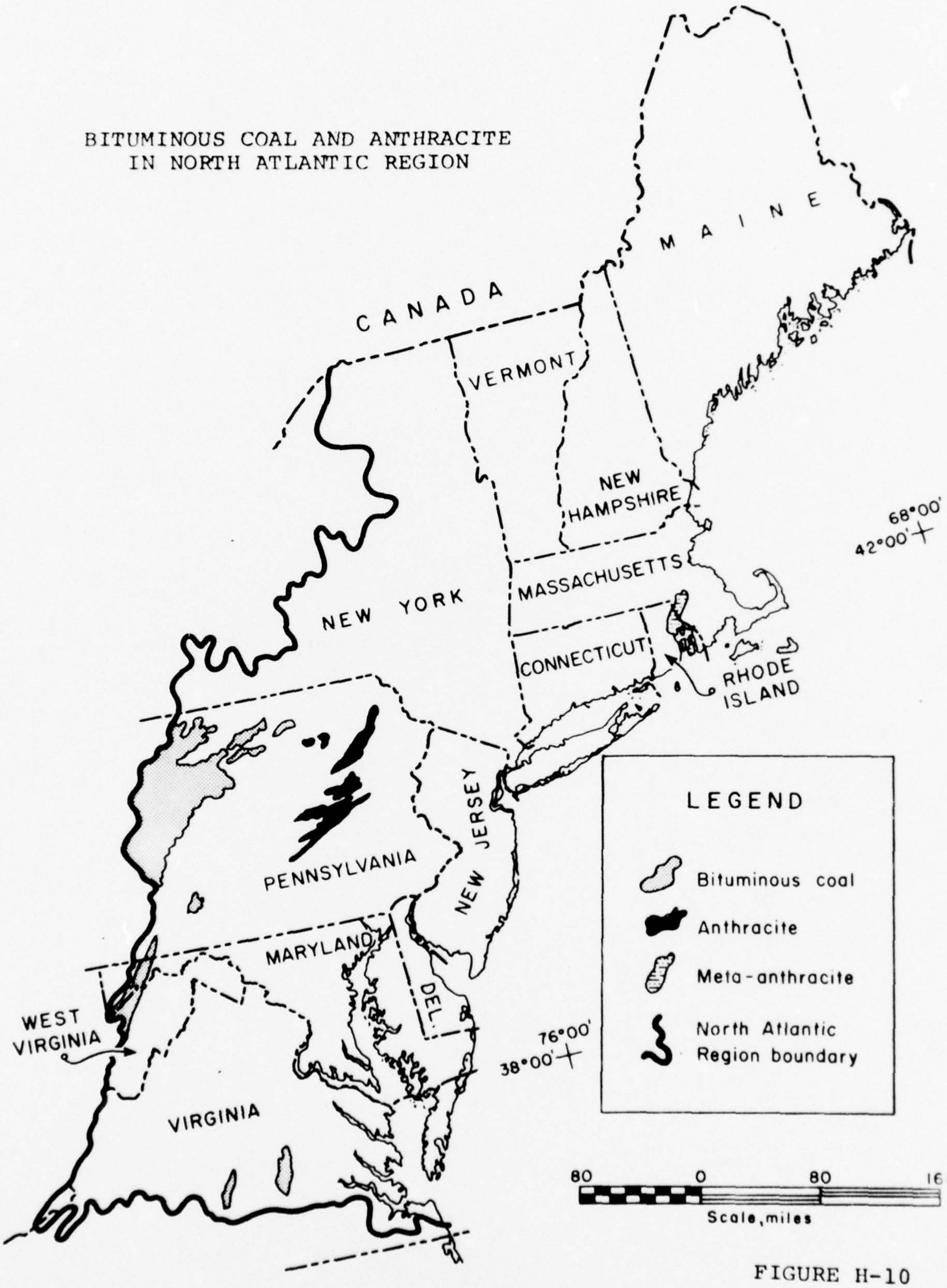
ANTHRACITE

Production and use. All of the Nation's anthracite is in the Delaware and Susquehanna Basins, in northeastern Pennsylvania as indicated in Figure H-10. Deposits of meta-anthracite in Basin 9 extend from Rhode Island into Massachusetts. These deposits were previously worked largely for their graphite content, but are not presently being mined. The Pennsylvania anthracite field covers about 485 square miles in 12 counties: Carbon, Columbia, Dauphin, Lackawanna, Lebanon, Luzerne, Northumberland, Schuylkill, Sullivan, Susquehanna, Wayne, and Wyoming.

There are as many as 26 minable anthracite beds separated by layers of intervening shale, sandstone, or conglomerate ranging from a few feet to as much as 200 feet thick. Anthracite thicknesses range from a few inches to as much as 60 feet, and thicknesses of 100 feet have been found where the strata have been tightly folded. Anthracite production has been declining since the 1917 peak year when nearly 100 million tons was produced. In recent years, output has declined from 44.1 million tons in 1950 to 9.7 million tons in 1970. In the period 1960-70 (Table H-4), production dropped at an annual rate of 6.4 percent. During this same decade, tonnages recovered from underground mines declined from 41 percent of total production in 1960 to 18 percent in 1970. Strip-mined tonnages in this period increased from 38 percent to 47 percent; culm production increased from 18 percent to 31 percent, and output from dredge operations remained stable at about 4 percent. The declining trend for underground production is attributable to the high cost of deep mining of anthracite due to high labor and pumping costs.

The principal markets or uses in 1964 included retail deliveries, 3.33 million tons; electric utilities, 2.24 million tons; iron and steel, 1.5 million tons; and exports, 1.58 million tons. Domestic anthracite shipments included 2.2 million tons to Pennsylvania, 1.3 million tons to New York, 640,000 tons to New Jersey, and 380,000 tons to the New England States.

Relationship to water. The greatest problem of the anthracite industry is control of underground water. Subsidence is a natural sequel to deep coal mining, particularly after the removal of pillar coal. The drawing of pillars causes the overlying rock strata to fracture and collapse into the voids left by mining. In some instances, fracturing and subsidence in and near streams have been so severe that much or all of the water has been diverted to form pools in underlying mines. Generally, anthracite is mined only to the water table, with only a few underground mines at present pumping to control water in workings below it.



BITUMINOUS COAL AND ANTHRACITE IN NORTH ATLANTIC REGION

FIGURE H-10

TABLE H-4

Production of Pennsylvania Anthracite, 1960-70

(thousand short tons and thousand dollars)

	Production					
Year	Underground	Strip	Culm	Dredge	Total 1/	Value
1960	7,696	7,112	3,297	712	18,817	$147,116
1961	6,785	7,247	2,669	746	17,446	140,338
1962	6,673	6,822	2,671	727	16,894	134,094
1963	6,715	7,468	3,393	692	18,267	153,503
1964	5,889	7,177	3,413	705	17,184	148,648
1965	5,297	5,939	2,930	700	14,866	122,021
1966	4,088	5,253	2,938	662	12,941	100,663
1967	3,258	4,740	3,627	632	12,256	96,160
1968	2,450	4,696	3,709	606	11,461	97,245
1969	2,106	4,579	3,253	535	10,473	100,770
1970	1,742	4,541	3,036	409	9,729	105,341

1/ Data may not add to totals shown because of individual rounding.

Demand for anthracite began to decline after World War I, and by 1920 many mines had been abandoned because of exhausted reserves or unprofitable operations, usually a result of the cost of pumping water. Water accumulated in these old mines and in abandoned areas of active mines. Some of these were interconnected, but in other instances barrier pillars failed and allowed water from an abandoned mine to flow into an active mine and flood the workings. These conditions have been cumulative and have spread from mine to mine. Comparatively few of the abandoned mines were without reserves and billions of tons of anthracite are inundated by these water pools.

Waters of the anthracite region have become acid, iron, and manganese bearing, as a result of water in the mines chemically reacting with pyrite present in the coalbeds and surrounding rock strata. Treatment and purification of this water is of serious concern to the region and to the industry. Mine drainage adds immense quantities of acid water in the Region's rivers.

The use of water in anthracite mining is negligible. Water used in processing amounted to 31,864 million gallons in 1962, which was still less than 1 percent of the total used by the Nation's mineral industry. Discharged process water containing silt and fine coal has caused siltation and increased flood damage.

Outlook. Anthracite mining and production are projected to decline until 2000 when a leveling off will occur at about 3 million tons per year. The decline is attributable principally to the loss of some markets and increased mining costs. The sharpest decline will be in space heating, anthracite's major market. In previous years, the smokeless quality of anthracite was attractive to consumers. Total consumption for household and commercial space heating declined from 28 million tons in 1949 to 4.7 million tons in 1968; an average annual decline of 8.9 percent. Competitive fuels such as oil, natural gas, and electricity have replaced anthracite in the space heating market because of their convenience and low installation costs.

Electric utility and other manufacturing industries which have traditionally used anthracite as a source of fuel have found bituminous coal, fuel oil, and natural gas more economical. Some electric utilities have switched to bituminous coal because of lower fuel costs realized through use of unit trains from producing areas outside the anthracite region. In addition, supplies of the smaller sizes of anthracite produced by dredges and at culm and silt banks are becoming depleted.

BITUMINOUS COAL

Production and use. Bituminous coal occurs and is mined in many parts of the United States. In NAR it is found in an area along the western border of the Region in several counties of Pennsylvania, Maryland, and West Virginia as indicated in Figure H-10. Small isolated fields also are found in central and eastern Virginia, but no production has come from these fields in many years.

Coal has been mined from 13 or more seams in the Region in recent years, but more than 90 percent of the production has come from five seams in the Susquehanna River Basin: the Upper and Lower Freeport, and Upper, Middle, and Lower Kittanning seams. The Brookville and Clarion seams also are important producing beds.

In 1964, bituminous coal production in NAR was 31 million tons valued at $137.7 million, almost 7 percent of the national output of 487 million tons. About 92 percent of the Region's production was mined in Pennsylvania in the Susquehanna River Basin, the remainder came chiefly from the Potomac River Basin in Maryland and West Virginia.

In 1964, there were more than 1,200 bituminous coal mines in the Region, about 1,150 in the Susquehanna Basin in Pennsylvania and less than 70 in the remainder of the Region in Maryland, Virginia, and West Virginia. Counties with output greater than 1 million tons in 1964 were--in descending order--Cambria, Clearfield, Indiana, Somerset, and Jefferson, all in Pennsylvania. Clearfield County had the largest number of strip mines and the greatest production by that method; Cambria County had the greatest production from underground mines.

The largest and most rapidly growing use for bituminous coal is for electric power generation. Of the bituminous coal consumed in 1964, 47 percent was used by electric power utilities, 20 percent was for coke manufacture and other metallurgical uses, 19 percent went into other manufacturing (including cement manufacture), 4 percent was sold to retail dealers, and 10 percent represented net foreign exports. Distribution data for the North Atlantic Region's bituminous coal shipments are not available.

Relationship to water. Problems resulting from bituminous coal mining are related to acid mine drainage from surface and underground mines, subsidence from deep mining, disturbance of surface by strip mining, and storage of waste from coal washing plants. When water from ground and surface sources and atmospheric oxygen come into contact with pyrite in the coalbeds and adjacent strata, exposed through mining, a chemical reaction takes place. Water soluble acid sulfates (sulfuric acid, ferrous sulfate, and ferric sulfate) are formed and this acid is often discharged to surface streams by pumping or gravity flow. Streams are polluted by the acid drainage and accompanying insoluble iron sulfate (yellowboy). Acid formation also occurs through waters draining from surface strip pits and coal waste piles.

Water used in mining is mostly spray water in cutting and drilling operations. However, when coal is cleaned, large quantities of water are used. In 1964, it was calculated that 905 million gallons of new water was needed by those producers reporting water use. In future years, it is probable that a greater percentage of the coal mined will be mechanically cleaned.

Outlook. Demand for bituminous coal in the United States is expected to more than double within the next 30 years, and demand for NAR production is expected to double within 50 years. Demand for coal for power generation will continue to grow. In 1968, 295 million tons of bituminous coal and lignite was used by electric utilities in the United States; 59 percent of the total domestic demand. Consumption of coal for power is increasing at the rate of 6.8 percent per year. Reserves of bituminous coal in NAR are large but the Region's share of the energy market is dependent on many economic and technological variables. Coal production in the Region is expected to keep pace with national trends.

PETROLEUM AND NATURAL GAS

Production and use. Extensive metamorphic and volcanic rocks in a geologically complex setting and a paucity of marine sediments characterize much of NAR. Consequently, commercial deposits of petroleum and natural gas are not widespread, and the prospect of finding additional deposits is limited. The few localities in NAR where oil and gas have been found lie near the western boundary of the Region, west of the Valley and Ridge and Blue Ridge Provinces, and southwest of the Adirondack Mountains in the Susquehanna River Basin (17), and the Potomac River (19) and James River Basins (21). In Basin 17, commercial deposits of natural gas are not uncommon from central Pennsylvania northeastward through central New York. Ultimate recoveries from individual gas wells tend to be mediocre, although a few wells have not only yielded large volumes, but also have recorded high initial rates of production. These circumstances are unusual, though, and are probably the result of drilling into reservoir rocks with extensive natural fractures but otherwise of low permeability.

Only two oilfields have been discovered in NAR, both in the Susquehanna River Basin (17) in Pennsylvania. St. Mary's field, in east-central Elk County, has about 18 wells and produces from the Queen sand (Upper Devonian). The Gains field, in west-central Tioga County, has about 56 wells and produces from the Atwell and Blossburg sands (both Upper Devonian). The latter field is significant because it is the most easterly oilfield along the regional strike in NAR.

Natural gas has been found in western New York in the region southwest of the Adirondack Mountains in Basin 17. Some commercial production has been obtained. Additional shows of gas point to the possibility that other commercial deposits will probably be found in this area of NAR. Specifically, this includes western Delaware and Otsego Counties, Herkimer County, and counties west of these. Commercial oil production in New York occurs only in Cattaraugus and Allegany Counties, and in a very small portion of southwestern Steuben County; all of this area lies outside NAR.

In Pennsylvania, production of natural gas has been reported from fields in Cameron, Clearfield, Clinton, Potter, and Tioga Counties.

In the southern portion of NAR, natural gas production comes from about seven wells in the Mountain Lake Park field, and from three wells in the Negro Mountain field, both in Garrett County, Md. (Basin 19). Production comes from the Oriskany sand (Devonian). A one-well extension of Pennsylvania's Artemus field (Bedford County) is located across the state line in Allegany County, Md.

Natural gas has been found in Oriskany sand in Rockingham County, Va. (Basin 19). Additional shows of gas have been reported in exploratory wells to the southwest, but outside of NAR. Well density in the intervening area is extremely low, as it is elsewhere in the western portion of NAR in Maryland and Virginia. It is not unreasonable to believe that further exploration will uncover additional reserves of natural gas.

Relationship to water. Water is not used in the production of petroleum and natural gas except for limited quantities used in drilling and hydrofracking. After production at a crude petroleum well begins, care must be exercised to avoid water pollution by spills of brine separated from the petroleum and/or from the petroleum itself.

Outlook. The sedimentary basins, found in the Piedmont of Maryland and Virginia (Basins 19, 20, and 21), contain sediments of Triassic Age, and are probably of continental origin. It is doubtful if petroleum or natural gas occur here in significant quantities.

The most promising area for future discoveries of oil and gas in NAR is off the Atlantic coast. Geophysical crews have conducted numerous surveys in recent years. A consortium of oil companies recently established the presence of stratigraphically significant cretaceous formations structurally capable of accumulating hydrocarbons on the continental shelf approximately 100 miles southeast of Cape Cod. Within the boundary of NAR, additional discoveries of natural gas, and perhaps minor discoveries of oil, will undoubtedly be made in the areas already described when deeper sections of the geologic column are penetrated.

METALS

BASE METALS

COPPER

Production and use. Copper mining has been carried on at many localities in NAR in the past, but production from these operations was limited. Currently, the only active operation is at Harborside, Me. (Basin 5). Copper also is recovered as a byproduct of magnetite mining in Pennsylvania.

Most of the United States copper production is outside NAR and is from western States. Copper concentrators and smelters are usually near the large mines; only one primary smelter is located in the Northeast in New Jersey. However, about 59 percent of the electrolytic-refining capacity and 61 percent of the total output is accounted for in six refineries on the Atlantic Coast in New York City, N.Y.; Carteret and Perth Amboy, N.J.; and Baltimore, Md. Twenty copper fabricating plants are located in the New England States, most of which are in the Connecticut Valley area. Other fabricating plants are located in the Middle Atlantic States.

Copper is valuable both as a pure metal and as an alloy with other metals, and its uses are numerous and varied. The greatest consumption of copper is in electrical applications such as power generation and transmission, communications, industrial and home electrical equipment (marine, air, and land). Other applications of copper and copper alloys include pipe and tubing for air conditioning, plumbing, and fluid and gas transmission lines. Additional uses are in jewelry, coinage, home utensils, brass and bronze, and furnishings utilizing the metal's decorative properties.

Copper deposits, prospects, and occurrences are indicated in Figure H-11.

In Maine, the coastal area from Penobscot Bay to the Canadian border and the inland watersheds of all streams entering the Atlantic Ocean (Basin 5) comprise the district containing most of the known copper deposits.

Callahan Mining Co. is currently producing copper and zinc from its Cape Rosier mine near Harborside. Another deposit at Blue Hill has been extensively explored and production may soon begin. In Area A, covering Hancock and Washington Counties, 10 other prospects are known. Further prospects are in Washington and Somerset Counties.

Copper deposits in New Hampshire are centered in two main localities (Areas A and B) in Basin 8 and 4, respectively. In the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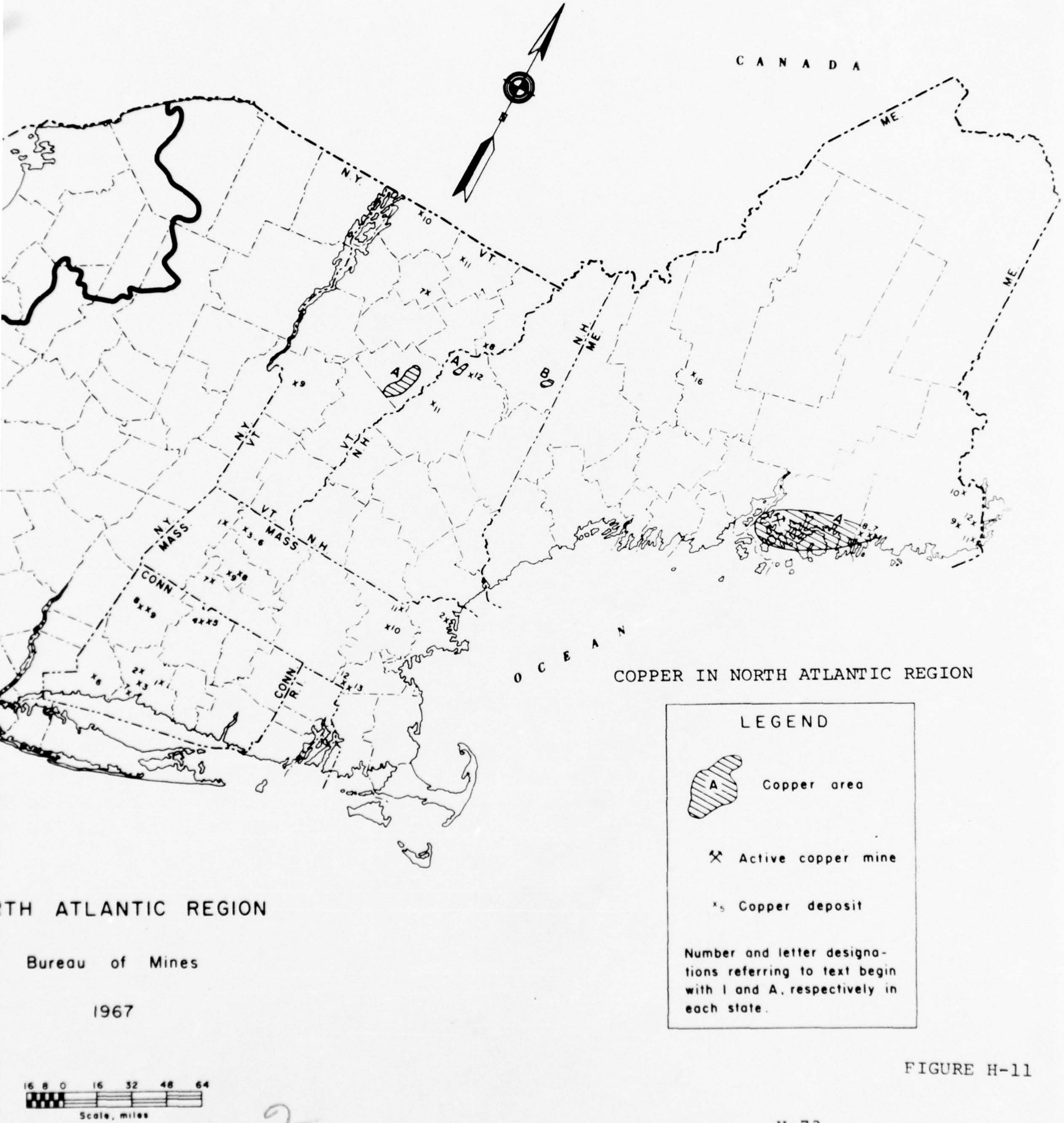

Number and letter designations referring to text begin with 1 and A, respectively in each state.

COPPER IN NORTH ATLANTIC REGION

FIGURE H-11

2

Gardners Mountain area in Grafton County (Area A), 10 mine localities are known, and in Coos County (Area B), three prospects are located.

In Vermont, six inactive mines and prospects are located in Orange County in Basin 8 (Area A). Other deposits are in Basin 11 in Lamoille, Essex, Rutland, Franklin, and Orleans Counties. Deposits of copper in Massachusetts are mainly in the western counties of Basin 8; some are in Basin 7. The principal copper deposits and prospects are in the western counties of Basin 10. In the Connecticut portion of Basin 8, two inactive mines are located near Granby. Other deposits are in Basin 10; one in Fairfield County, two in Litchfield County, and four in New Haven County.

Ten principal copper prospects or inactive mines are known in New Jersey, seven in Basin 14 and three in Basin 15. Copper occurrences in Pennsylvania are located in Adams, Franklin, Lancaster, and Montgomery Counties. Copper is recovered as a byproduct of magnetite mining at the Grace mine of Bethlehem Mines Corp. in Lebanon County.

Copper deposits in Maryland are in two main areas (Area A and B) in Basins 18 and 19, respectively. There are six inactive mines each in Carroll and Frederick Counties.

In Virginia, minor quantities of copper were produced in previous years from pyrite mines in the Gold Pyrite Belt, indicated in Figure H-9. Inactive mines are located in Amherst County (Area A), Buckingham County in Basin 21, and elsewhere.

Relationship to water. Copper mining in NAR is limited to one mine in Maine but water use data are not available for this operation. However, by referring to the data of a 1962 survey on water-using, copper-ore producing companies of the United States, some assumptions can be made. Water used by the copper industry in the United States in 1962 averaged 1,045 gallons per ton of crude ore produced. Of this total, 18 gallons were used in mining, 861 gallons for processing, and the rest for other uses. As indicated, the bulk of the water requirements by copper producers would be in processing ore at concentrating mills in flotation circuits. The impact of this water usage would only have a local impact in a few isolated areas since the possibility of large scale copper mining in the Region is remote.

Outlook. It is expected that demand for copper in the United States will increase substantially in the future. If national needs require it and if it is economical to mine, some new copper mines in NAR can be expected to come into being within the next 30 years.

LEAD AND ZINC

Production and use. In 1964, lead produced in NAR was a byproduct or coproduct of zinc mining. Lead output is combined with zinc in this report. Production during 1964 in New York was 61,000 tons valued at $16.5 million; New Jersey production was 33,000 tons valued at $9.0 million; and Pennsylvania production was 31,000 tons valued at $8.3 million. Production in the NAR portion of Virginia ceased in 1962 when 6,000 tons was produced. Total production in 1964 in NAR and the United States is shown in Table H-1.

Zinc is a chemically active element which alloys readily with other metals. The relatively high position of zinc in the electromotive series accounts for its extensive use as a coating to protect iron and steel products against corrosion. Other important uses are in die castings, wrought or rolled zinc products, an alloy constituent of brass, and zinc oxide.

Lead is used industrially both in its metallic form and in compounds. About 55 percent of U.S. lead consumption is for storage batteries and tetraethyl lead. The remainder is used in cable covering, paint pigments, building construction, ammunition, and various alloys, chiefly solder, and bearing and type metals.

As indicated in Figure H-12, lead-zinc occurs in all States of NAR except Delaware and Rhode Island. Some occurrences contain only lead or zinc, but most contain both metals in varying proportions. Generally, primary ores of lead and zinc are closely associated mineralogically. Some ores are complex and contain copper, iron, gold and silver, and occasionally nickel, cobalt, arsenic, and other metals. Various combinations of minerals may occur in complex deposits and lead and zinc may be of paramount, secondary, or of only minor commercial importance.

A review of the various deposits follows:

Maine--Lead and zinc occurrences are found in three general areas - coastal, northern, and western. The coastal area of Hancock and Washington Counties (Basin 5), predominates in the number of deposits. Two companies in Hancock County are engaged in exploration and development work for production of copper, lead, and zinc ores. The deposits are near Blue Hill and Harborside. The Blue Hill deposit has been explored and developed extensively and is reported to be ready for production. Six other principal deposits and prospects are located in Hancock County. In Washington County, three occurrences are known, and in the western area, there is one each in Oxford, Somerset, and Franklin Counties. In the northern area (Basin 2), an occurrence has been reported near New Limerick, Aroostook County.


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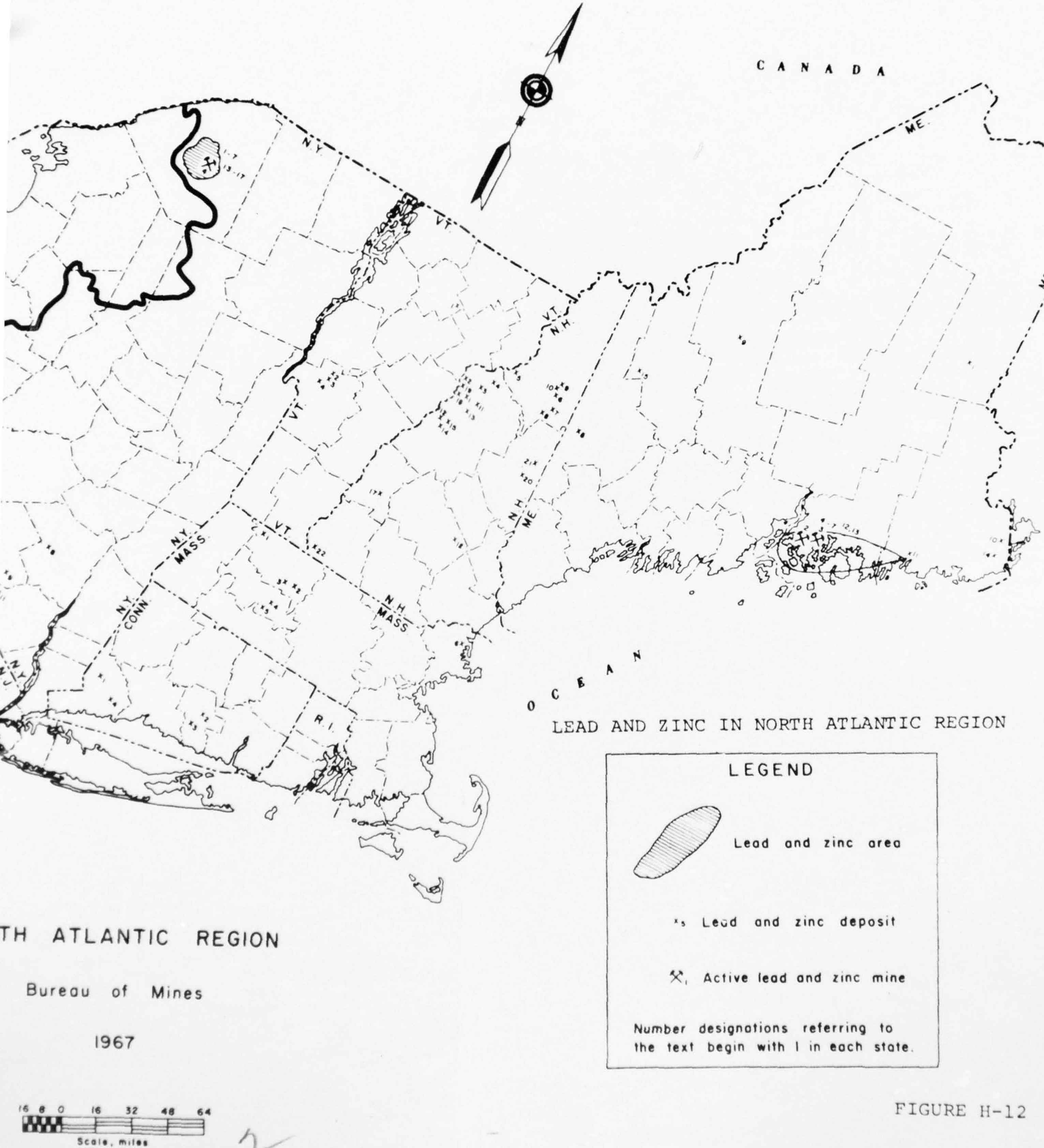

LEAD AND ZINC IN NORTH ATLANTIC REGION

FIGURE H-12

New Hampshire--The State is underlain by a thick sequence of schists, phyllites, slates, quartzites, impure marbles, and volcanics which have been downfolded into a major north-south trending syncline, intruded in places by granitic rocks and broken by thrust faults. Distribution of some lead and zinc deposits appears to have been structurally controlled by major thrust and normal faults, which are close and parallel to the Connecticut River, and by fractures along the flanks of plunging anticlines along this same river. Most of the lead-zinc deposits lie along the eastern side of the Connecticut River Basin but a few occurrences are east of the White Mountains. Deposits are found chiefly in Grafton and Coos Counties with 11 and five principal localities, respectively. Other counties having lead-zinc deposits are: Merrimack (1), Carroll (2), Sullivan (1), and Cheshire (1).

Vermont--Bedrock in Vermont is similar to that of New Hampshire, underlain by thick sequences of schists, phyllites, slates, quartzites, impure marbles, and volcanics. The syncline, mentioned in New Hampshire section, continues into Vermont and is broken by thrust faults and bordered on the west by the Green Mountain anticline. Three lead-zinc prospects are located in Rutland County and one in Lamoille County, all within Basin 11.

Massachusetts--Most lead-zinc occurrences are found along the Connecticut River where conglomerate, sandstone, arkose, shale, thin limestone, and basaltic lava flows dip gently eastward. These rocks have been intruded by diabase sills and dikes and are broken in places by normal faults which trend northeast and have a displacement of several hundred feet. Mines or prospects are located as follows: three in Franklin County, two in Hampshire County, and one in Essex County.

Connecticut--The bedrock in the Connecticut River Basin is similar to that of Massachusetts. Some of the lead-zinc mineralization occurs in narrow veins along fault zones between schist and conglomerate. Glacial till and sand and gravel obscure most of the bedrock. No lead-zinc production has been reported in recent years but two inactive mines each are located in Middlesex and Fairfield Counties.

New York--The crystalline rocks of the northwestern Adirondack Mountains are overlapped on the west and north by metamorphosed sandstone, limestone, and dolomite which outcrop chiefly along the St. Lawrence River. Bedrock of southeastern New York consists of metamorphic and igneous rocks of the Appalachian Mountain belt. The zinc occurs in overlapping lenses and pods replacing impure limestone. Active lead-zinc mines are in Basin 11, located near Edwards and Gouverneur, St. Lawrence County. Within the county, numerous inactive mines and deposits are near Rossie, Malcomb, Edwards, Balmat, and Gouverneur. Other deposits are situated in Orange (3), Ulster (1), and Sullivan (2) Counties, all in Basin 12.

Pennsylvania--The lead-zinc deposits in this State are usually found in the intensely folded rocks of the Appalachian Mountain belt. Lead-zinc prospects or occurrences have been reported in 20 counties in Pennsylvania. The only active mine in the State is at Friedensville, Lehigh County, in Basin 15.

New Jersey--Principal deposits of lead and zinc occur in Sussex County where the bedrock is composed of metasediments intercalated with granite, gneiss, and pegmatites, and overlain by more recent sediments. At location 1 (Figure H-12), Sussex County, the Franklin and Sterling Mines have been large producers of zinc for over 100 years. The Franklin Mine has been worked out and abandoned but the Sterling Mine at Ogdensburg is still producing manganiferous zinc ore. Other inactive mines are located near Andover, Sussex County.

Maryland--Long inactive lead and zinc mines and prospects are located in the Piedmont upland of western Maryland where bedrock is gneiss, quartzite, schist, marble, phyllite, and greenstone intruded by granitic, gabbroic, and ultramafic rocks. The ore occurs as replacement stringers in limestone between slate and crystalline limestone. Lead-zinc localities are in Frederick County (3) and Carroll County (2), both in Basin 19.

Virginia--Ore deposits in the Piedmont region generally consist of steeply dipping veins composed chiefly of pyrite, with accompanying chalcopyrite (copper), sphalerite (zinc), and galena (lead). The veins occur in crystalline metamorphic rock associated with intruded igneous bodies. Within the North Atlantic Region there are several inactive lead-zinc mines.

West Virginia--The area where zinc occurs has a geologic setting similar to that of the northern Piedmont of Virginia. There is only one deposit in the State and although it has never been worked, commercial possibilities are present. This mine is in Basin 19, located about 7 miles southeast of Charlestown near the east shore of the Shenandoah River in Jefferson County.

Relationship to water. In 1969, the Sterling Mine, Sussex County, N.J., produced about 25,000 tons of metal in direct shipping ore. The water used was calculated to be 273 million gallons, of which 4 million was recirculated. Nearly all the water was discharged, with about 15 million gallons being treated by chlorination and 2 million gallons consumed. About 8,300 gallons was used per ton of metal and 31 gallons was used per dollar of product produced.

The Balmat and Edwards zinc mines in New York State produced nearly 61,000 tons of metal using 626 million gallons of water, of which 619 million gallons was discharged, and the balance was consumed. None of the discharged water was treated. An average of 10,300 gallons of water per ton of metal and 38 gallons per dollar of product were used during the year.

The mine near Timberville, Rockingham County, Va., was closed in mid-1962 because the ore was depleted. During the time of operation over 6,000 tons of zinc and lead was produced using 23 million gallons of water, of which 1 million gallons was recirculated. Nearly all the water used was discharged without treatment. About 3,800 gallons of water were used per ton of metal produced.

Outlook. The long-term upward trend of United States lead and zinc consumption is expected to continue. New discoveries can be expected to maintain domestic production at or about its present share of the domestic market. New discoveries and new mines have not been developed in NAR. Unless exploration and development increase, NAR production will decrease as mines are depleted.

It is probable that in the long term new mines will be developed as older mines are depleted in NAR. This will result in approximately the same water use, but in different localities.

FERROUS METALS

CHROMITE

Production and use. Chromite has not been mined in NAR since the end of the Civil War. Sporadic attempts to mine chromite since then have been unprofitable. About 60 percent of chromite consumed is used in alloys and 30 to 35 percent for refractories. The balance is used in chemicals.

The Piedmont Upland of Maryland and Pennsylvania is the only area in NAR that has a record of past chromite production (fig. H-13). The serpentine rocks of this region have been mined for both high-grade massive ore and low-grade disseminated chromite, both grades of which occur in irregular and unpredictable form. Placer deposits are found in and near streams that drain the areas of serpentine rock deposits.

In Basin 17, 18, and 19 of Maryland, chromite occurrences are located in five principal areas which extend in a northeasterly direction from Montgomery County through Howard, Carroll, Baltimore, Harford, and Cecil Counties, continuing into Basin 15 in Pennsylvania. In Maryland, four mines and prospects and four placers, all inactive, are in Area A. Areas B and C have one and two inactive mines and prospects, respectively. In Area D there are five inactive mines and one placer occurrence. Only one inactive mine is in Area E. However, within the area are six placer deposits and 12 stream beds with values in chromite.

In Basin 15 in Pennsylvania, two inactive mines are in Area A. Placers in the area are found principally along Conowingo Creek and its tributaries. In Area B, 14 inactive mines and prospects and three placers are situated. Areas C and D have two and three inactive mines and prospects, respectively. Also within Area D are placers in stream valleys of Chrome Run and Chester Creek.

Some low-grade chromite occurrences are known in Maine. None of these deposits have commercial possibilities, and since the average grade is less than 0.35 percent chromite, no effort has been made to map the locations.

Relationship to water. In the event that it becomes necessary to mine the low-grade chromite ore deposits in NAR, the crude material will require beneficiation involving the use of water; probably not less than 500 gallons per ton of crude ore treated. The processing and beneficiation of low-grade chromite ore under present technology would not have any deleterious effect upon water quality provided that flotation reagents are neutralized and suspended solids are removed before water is discharged.

Outlook. Future potential of chromite deposits in NAR is probably limited to mining the reserves of low-grade disseminated chromite if the value increases severalfold or in a national emergency. Major changes in the supply and use patterns during the next 10 to 20 years will involve increasing use of chromite fines and concentrates, increasing use of different types of chromite ore, and reliance on relatively few sources. World reserves of metallurgical and chemical grade chromite are more than adequate for many decades, but known reserves of refractory grade ore are not large. Almost all chromite used in the United States today is imported, because more than 90 percent of the domestic chromite resources consist of low-grade, high-iron deposits. Unless technology develops methods to upgrade domestic ore into usable concentrates, the future of domestic chromite ore production in NAR is bleak.

IRON ORE

Production and use. The iron ore producing States in NAR in 1964 were New Jersey, New York, and Pennsylvania. Water users produced 4.4 million tons of iron ore concentrate valued at $71.5 million. Table H-1 contains additional data comparing NAR production with that of the United States.

Iron ore, in addition to supplying metal for iron and steel products, is used in pigments, cement, refractories, fluxing agents, and as a constituent of some catalytic agents. Magnetite, one of the ore minerals also is used for aggregate in concrete, as a shielding material in nuclear power plants, as a medium in jig beds and sink float plants, and as ship ballast.

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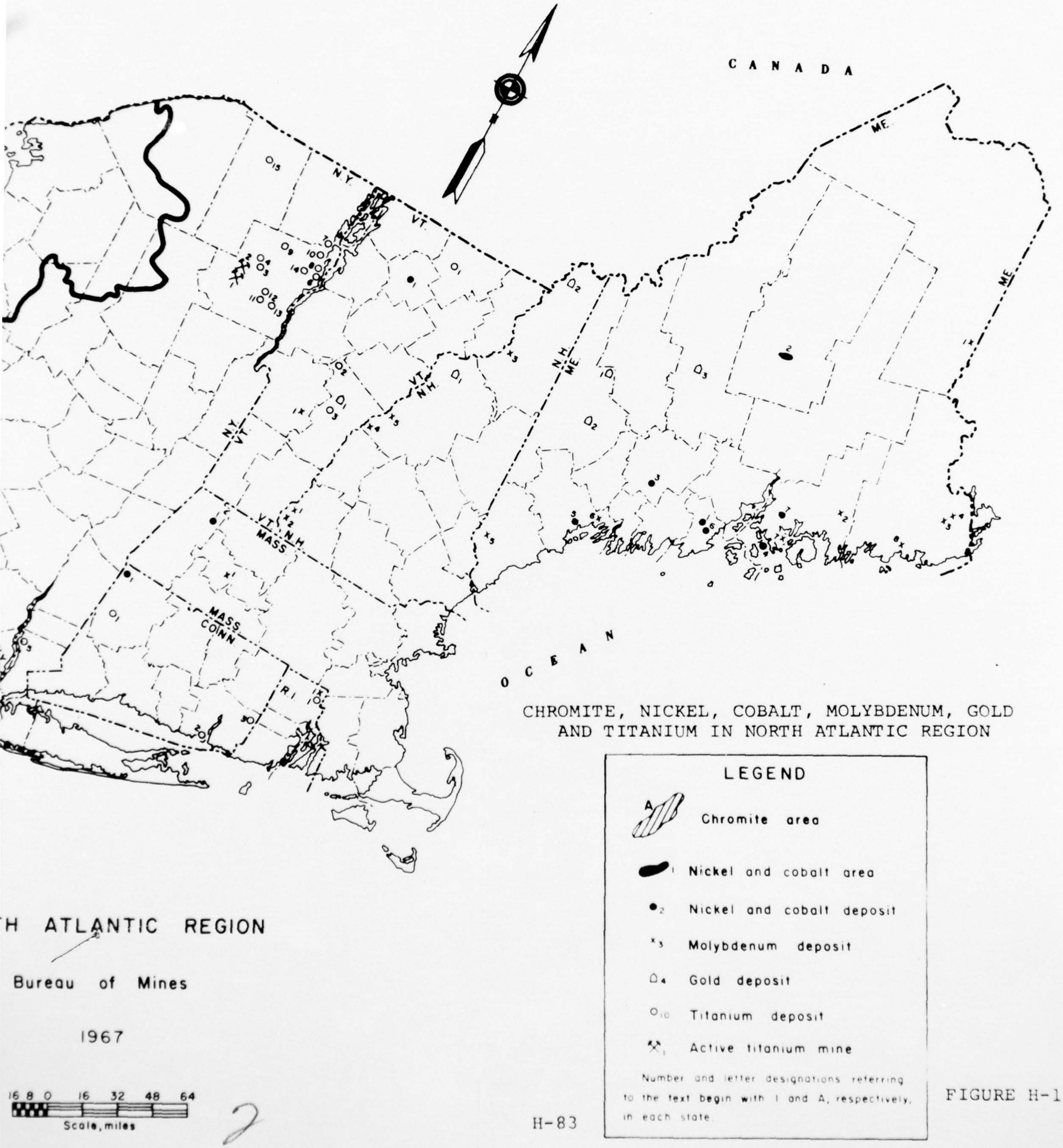

CHROMITE, NICKEL, COBALT, MOLYBDENUM, GOLD AND TITANIUM IN NORTH ATLANTIC REGION

FIGURE H-13

Various deposits of iron ore exist throughout the Region and are indicated in Figure H-14. Iron ore deposits may be divided into four main types on the basis of their mineralogy and in order of economic importance: 1) magnetite, 2) titaniferous-magnetite, 3) hematite, and 4) limonite. A review of the significance of the deposits within each State is as follows:

Maine--The principal potential sources of iron in Maine are in Basin 1 in bedded, manganiferous, iron-bearing deposits in Aroostook County and the pyrrhotite deposits at Katahdin. The manganese-bearing sedimentary rocks of Aroostook County are hematite slates and banded hematite. Folding and metamorphism converted some of the hematite into magnetite. These manganiferous iron deposits are in three districts. The Northern District, Area A, west of the towns of Presque Isle and Caribou, is 25 miles long with a maximum width of 18 miles. There are 22 reported prospects or deposits in the Northern District, of which the principal occurrence is the Dudley Deposit, west of Presque Isle. The Central District, Area B, is 15 miles west of Bridgewater by road and 21 miles north of Houlton; it is about 1-3/4 miles long and over 1/2 mile wide. The main deposit of the Central District is in the Maple Mountain-Hovey Mountain Region. The Southern District, Area C, centering around Houlton is 13 miles long and 8 miles wide. The Southern District was investigated by the Bureau of Mines in 1963 and 1956 and seven important deposits were found. Bog iron ore (limonite) has been produced at many localities and many other deposits are known, but are too small and variable in grade to be mined economically under present conditions. A few small deposits of hematite have been found; the principal deposit is in the town of Wade, in the Northern District. Magnetite has been reported in veins in granite but none of the deposits are commercially important.

New Hampshire--All iron deposits are too small for commercial development at the present time. Magnetite was mined at 17 principal localities within the State but mostly before 1865.

Vermont--A discontinuous belt (Area A) of mixed kaolin, ocher, sand, and low-grade manganiferous iron extends through Rutland and Bennington Counties to the Vermont-Massachusetts line in Basin 8. The belt is along the western foothills of the Green Mountains and is approximately 90 miles long and as much as 2 miles wide. In places, the belt contains veins of iron and manganese ores. Within this belt, in Windsor County, deposits were worked and the ore was smelted locally. Irregular distribution, pockety occurrence, and variable quality of the ore were principal causes of failure in many of the mining operations in this belt. A number of iron deposits in Rutland, Chittenden, and Orleans Counties have been investigated by the U.S. Bureau of Mines.

Massachusetts--Iron deposits are found principally in limestone, shale, and gneiss. An iron industry in the western part of the State (Area A) was based on limonite deposits in the Stockbridge limestone. This district extends into Connecticut, Vermont, and bordering New York State and lies principally in Basin 10. Magnetite has not been commercially important but deposits occur in Franklin (3) and Hampden (1) Counties. Bog ore was worked at a number of places in Essex and Hampden Counties. Siderite occurs with limonite in Berkshire, Essex, and Worcester Counties.

Connecticut--The Salisbury District in the western part of the State was one of the more important iron ore producing areas in the Nation in the early 19th century. The area has scattered deposits of limonite and goethite occurring in weathered limestone and schist. Even after the development of Lake Superior ores, this district continued to produce for a number of years. Although the iron content of the ore was only 40 to 50 percent, its low phosphorous and high manganese content made the Salisbury ore desirable for production of car wheels and ordnance. Principal deposits are near Salisbury, Lakeville, and South Kent. Small bodies of magnetite occur in many places. Siderite has been mined at Roxbury, Litchfield County. Bog ores have been mined from a number of deposits in New London, Windham, and Tolland Counties.

Rhode Island--Minor production of iron ore has been reported from four deposits in Providence County (Basin 9). A magnetite-ilmenite mixture (cumberlandite) containing about 30 percent iron and 10 percent titanium dioxide occurs in a peridotite intrusion at Iron Mine Hill in Cumberland, Providence County.

New York--In Basins 11 and 12, major magnetite deposits occur in the northern Adirondack Region and Hudson Highlands area (Areas A, B, C, D, E, F, and H). Active magnetite mines are in Clinton and Essex Counties. Numerous inactive mines and deposits are in Clinton (19), Essex (11), St. Lawrence (3), Washington (31), and Warren Counties (2). Area H, which extends from the Connecticut State line through Putnam and Orange Counties into Passaic County, N.J., contains 15 inactive mines or prospects. Deposits of titaniferous magnetite occur in the Lake Sanford area, Essex County (Area D). Magnetite as a coproduct of ilmenite is currently produced at the MacIntyre mine near Tahawus. Seven other titaniferous magnetite deposits are within Area D.

Hematite deposits occur in the Clinton formation of Silurian Age in the western part of the State (Basins 12 and 17). The beds crop out in a narrow belt that extends from Niagara Falls to Cherry Valley in Otsego County (Area I). The thickest beds extend from eastern Oneida County to western Wayne County. Another area of hematite deposits (Area G) extends from Antwerp township in Jefferson County to Canton township in St. Lawrence County. The ores were previously mined principally for pigment material.


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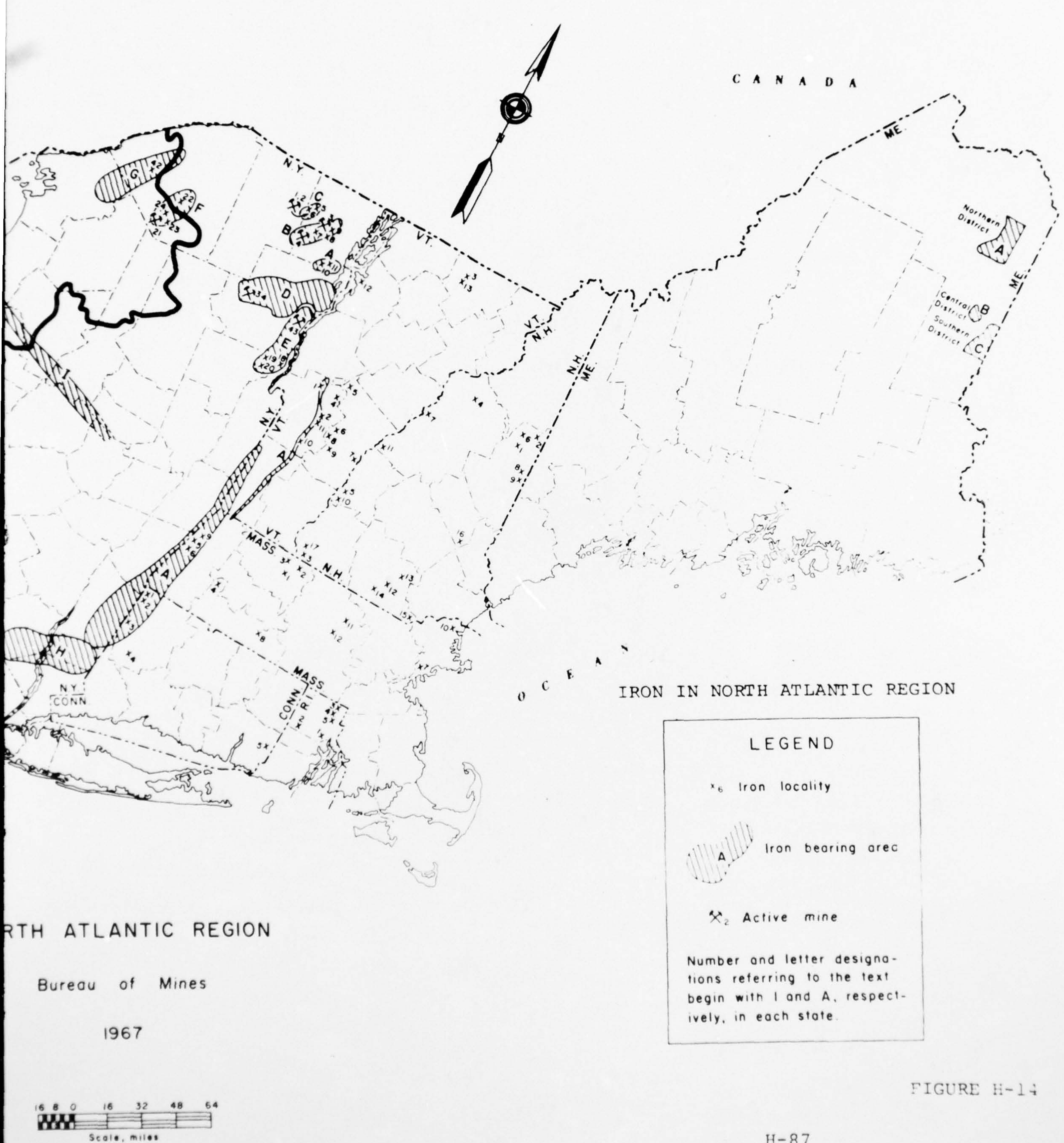

Number and letter designations referring to the text begin with 1 and A, respectively, in each state.

IRON IN NORTH ATLANTIC REGION

FIGURE H-14

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Although most of the ore is self-fluxing, the high mining costs and relatively low iron and high phosphorus content make the ore uneconomical to mine.

Several limonite deposits found in Dutchess and Columbia Counties represent an extension of the Salisbury District in Connecticut. The geology is the same as that for the Connecticut deposits. Siderite crops out in a belt 4 miles long near Greenpoint and Livingston, Columbia County.

New Jersey--Iron ores that have been mined were limonite, hematite, and magnetite. Limonite from bog ore deposits was developed in early years but more recently magnetite has been mined almost exclusively. Major magnetite deposits occur in Passaic, Warren, Morris, Sussex, and Hunterdon Counties in Basin 14 and 15. Numerous mines and prospects occur in Passaic, Warren, and Morris Counties and production continued until the mid-1960's in Morris County. Hematite deposits occur near Andover, Hamburg, and McAfee, Sussex County; and near Phillipsburg, Warren County.

Delaware--Bog iron ore was mined in Sussex County near the Maryland border early in the 19th century. Reserves are unknown but probably very little ore is left since the deposits were shallow and mining was discontinued in the 1840's.

Pennsylvania--Hematite, limonite, and magnetite have been mined within the State for many years. Hematite ores were produced in great abundance during the 19th century. Magnetite is mined currently at the Cornwall mine in Lebanon County and at the Grace mine in Berks County.

Hematite ore occurs chiefly in the Clinton Formation in Snyder, Mifflin, Perry, Juniata, Blair, Huntingdon, Bedford, Columbia, Lycoming, Montour, Union, and a few other counties. The ores are usually found near mountain slopes in thin, steeply dipping beds. Reserves of limonite are indicated at Boiling Springs, Cumberland County; near State College, Centre County; and in other deposits in Blair, Centre, and Huntingdon Counties.

Maryland--The known iron ore deposits are small and none have been mined in recent years. Inactive mines and occurrences are in Carroll and Cecil Counties (magnetite), and Frederick County (magnetite, hematite, and limonite).

Virginia--Principal iron ore deposits are found in the Piedmont, Blue Ridge, and Valley and Ridge provinces. Most of the iron has been obtained from mines in the Alleghany-Bath Limonite District which is located in Basin 21.

Inactive mines and deposits are located chiefly in Alleghany and Craig Counties. Additional mines and prospects in hematite deposits are located between Waynesboro and Roanoke (Area B). In Bath County (Area A), hematite occurs in the Clinton (sandstone) Formation. Magnetite and hematite deposits occur in a narrow belt along the James River from Norwood to Lynchburg (Area C). A few deposits of magnetite are along the James River in Nelson and Albemarle Counties.

West Virginia--Numerous hematite deposits were formerly worked in Grant, Hardy, Hampshire, Mineral, Monroe, and Pendleton Counties in Basin 19. Most of the prospects and pits were small and output was used locally.

Relationship to water. Iron ore production in NAR is concentrated using magnetic separation (wet or dry), tabling, gravity, or flotation methods. Settling or filtering is all that is necessary for the first three processes before discharging or recirculating water. Water from the flotation process may have to be treated to neutralize flotation reagents before discharge into surface channels.

The industry, in 1964, used nearly 18.9 billion gallons of water to mine and process nearly 5 million tons of concentrate; over 4 billion gallons of water was new and the balance recirculated. More than 3 billion gallons were discharged with 2.5 billion being treated by settling, 260 million by filtering, and the balance discharged without treatment.

Outlook. Production of iron ore in NAR is not expected to increase significantly.

MANGANESE

Production and use. Manganese and manganiferous ore were produced in NAR intermittently from the 1870's through 1959. Production was small in the early years and output was used locally. No manganese production has been reported in NAR since 1959 when the Federal Government ceased purchasing metallurgical-grade manganese from producers in Virginia. From 1952 through 1959, over 112,000 tons of manganese ore produced in Virginia was purchased at premium prices for the Federal stockpile. Manganiferous residuum is recovered as a byproduct of zinc smelting at Palmerton, Pa., from manganiferous zinc ore mined at Sterling Hill, N.J. (Basin 15).

Manganese is used principally in the production of steel as a desulfurizer and deoxidizer. Three major use categories for manganese are: 1) metallurgical, 2) dry cell battery manufacture, and 3) chemical. Manganese is used chiefly in the form of ferromanganese for metallurgical applications. Manganiferous residuum also is used as a ferroalloy.

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Deposits and areas of manganese occurrences are indicated in Figure H-8. A review of the deposits is as follows:

Three areas of low grade deposits of manganese are in the iron-bearing sedimentary rocks of eastern Aroostook County, Me., in Basin 1; another deposit is at Blue Hill, Hancock County (Basin 5). In New Hampshire, deposits are near Winchester and Hinsdale (Basin 8). Three deposits are indicated in Rutland County, Vt. (Basin 11), near Brandon, Chittenden, and South Wallingford. Other minor deposits in Vermont are in Bennington, Rutland, Orange, Addison, and Orleans Counties. Deposits in Massachusetts are in Hampshire (Basin 8) and Berkshire (Basin 10) Counties. Also in Basin 10 in Connecticut, deposits are near Salisbury, Litchfield County, and Redding, Fairfield County.

In Basin 12 in New York, deposits are located in Columbia, Dutchess, and Putnam Counties. Other small deposits not indicated in Figure H-8 are in Westchester, Orange, Essex, Albany, Warren, and Rensselaer Counties. Manganese deposits in New Jersey are in Sussex County (Basin 15).

Three principal areas for manganese are in Pennsylvania: in Lehigh and Berks Counties, Basin 15; in Dauphin, Lebanon, and Schuylkill Counties, Basins 15 and 17; and in Blair, Centre, and Huntingdon Counties, Basin 17. Other deposits in Basin 17 are in York and Cumberland Counties.

In Virginia, four principal manganese areas are shown in Figure H-8; two are within Basin 19, one in Basin 21, and another extends in a narrow northeast trending belt through Basins 19 and 21. Many inactive manganese mines are within this narrow belt in the western foothills of the Blue Ridge Mountains. Other occurrences in Basin 21 are in Botetourt and Rockbridge Counties; in Basin 19, an occurrence is indicated in Augusta County.

Relationship to water. Manganese is not produced in NAR at present, so water quality and pollution are not a problem. However, if production occurs in the future, concentrates will be produced using jigs, tables, and log washers. These processes all use water and pollution will be a problem unless control methods are employed. Quality of water for beneficiation is not important.

Outlook. The world supply of good quality metallurgical manganese ore is substantial and probably will not be of concern to users in the United States at least until 1980 if foreign supply sources remain open. If foreign supplies are not available, sources in NAR may be developed into producing mines or manganese nodules may be recovered from the ocean floor. The outlook for battery grade ore supplies from foreign sources is equally good, but should these sources vanish other types of batteries would be used. Technological advances in battery making and growing use of rechargeable batteries which do not contain manganese are expected in the future.

MOLYBDENUM

Production and use. Most of the United States production of molybdenum is from one mine in Colorado; other domestic production is chiefly as a byproduct of copper and tungsten mining. Molybdenum is used principally as a ferroalloy. Minor uses are as metal and in high temperature alloys and chemical applications. Although not produced in NAR, molybdenum deposits occur in the New England States.

Deposits and occurrences of molybdenum are shown in Figure H-13. In Maine, eight deposits or prospects are in Basins 1, 5, and 6 in Aroostook, Washington, Hancock, York, and Cumberland Counties. New Hampshire deposits are in Basin 8 in Cheshire, Coos, and Grafton Counties. Also in Basin 8, molybdenum is reported to be present in the ore of an inactive lead mine near Easthampton, Mass. In the Basin 11 portion of Vermont, one occurrence is reported in Rutland County. Molybdenum occurs in a deposit near Woonsocket, R.I. (Basin 9).

Relationship to water. If molybdenum mining were undertaken in NAR, beneficiation would be by flotation and water use would be on the order of 1000 gallons per ton of ore treated. The potential for water pollution would depend largely on the presence of other sulfide minerals.

Outlook. Deposits rich enough and large enough to be mined for molybdenum alone are not known in the Region. Future production is most likely to be as byproduct of base metal mining.

NICKEL AND COBALT

Production and use. Nickel- and cobalt-bearing ores of NAR have been found in sulfide deposits that typically consist of pyrrhotite, pentlandite, and chalcopyrite. These deposits occur in norite, peridotite, and related igneous rocks. The ore commonly contains 1 to 2 percent nickel, and 0.05 to 0.1 percent cobalt. At present, only cobalt is being produced in Pennsylvania as a byproduct of iron ore production. In years past, quantities of nickel ore also were recovered from deposits within NAR.

Nickel's principal use is in ferrous and nonferrous alloys, such as stainless steel and Monel metal, and electroplating. Other important uses are as catalysts and in batteries and magnets. Sintered nickel powder is used for filtering and purification of concentrated alkaline solutions. Other powder-metallurgy uses include aluminum-nickel-cobalt (Alnico) magnets, iron-nickel magnet cores, glass to metal seals, copper-nickel-tungsten heavy metal, and silver-nickel contact points.

Cobalt is used as an element in ferrous and nonferrous alloys, in the form of oxide, as ground coat for porcelain enamel, in pigment, and for cemented carbides; and, in the form of salts, in lacquers, varnishes, paints, and inks. It is also used in enamel, glass, and electroplating.

As shown in Figure H-13, nickel and cobalt deposits are indicated in Maine, Vermont, Massachusetts, Connecticut, Pennsylvania, New Jersey, Maryland, and Virginia.

In Maine, a nickeliferous pyrrhotite deposit is located in Union Township, Knox County (location 1, Figure H-13). The deposit, surveyed geophysically and explored by diamond drilling, was found to contain nickel, copper, and cobalt. Indications are that the nickeliferous deposits may be extensive. Other prospects are in Knox, Piscataquis, Hancock, Kennebec, and Cumberland Counties.

Talc recovered from a mine at Johnson, Vermont (location 1, Figure H-13), contains a nickeliferous pyrrhotite impurity. A representative sample of pyritic-nickel concentrate assayed 10 percent nickel.

A deposit of amphibolite containing nickel in disseminated copper and iron sulfides is located near Dracut, Mass.

Two nickel deposits are in Litchfield County, Conn. One is 5 miles west of Litchfield and the other is 1-1/2 miles west of Torrington.

Past production of nickel was reported from the inactive Gap Nickel mine near Kinser, Lancaster County, Pa. Quantities of cobalt are recovered as a byproduct from active magnetite mines in Berks and Lebanon Counties. Cobalt also is associated with other minerals in deposits in Huntingdon and Lehigh Counties.

In the Franklin Mining District, Sussex County, N.J. (location 1, Figure H-13), a mass of nickel-cobalt ore was mined at Trotter Shaft.

In Maryland, cobalt is contained in one of the minerals of the Patapsco Mine in Carroll County (Loc. 1). Cobalt also is one of the constituents of the ore from the Carroll mine near Finksburg, Carroll County (Loc. 2). Both of these deposits are small and cobalt is only a minor constituent of the ore.

Cobalt associated with manganese ores has been found on the northwest side of the Blue Ridge Mountains (Loc. 1 and 2) in Virginia.

Relationship to water. The relationship of water to the mining and processing of nickel and/or cobalt ores is minimal since these products in NAR are generally recovered as byproducts in the production of other metallic minerals. Usually the nickel and cobalt contents of these ores are recovered in the process of leaching or electrorefining of other metals.

Outlook. The consumption of nickel in the United States is expected to continue its steady increase resulting from the general economic growth. The United States consumes about 50 percent of the free world output, and will continue to do so in the immediate future. The prospect of finding nickel ore in large quantities in NAR or the United States is not good, but with present output or recent new finds in Canada, the outlook for adequate supplies for the U.S. is favorable. World output of cobalt will continue to exceed consumption and therefore supplies are expected to be ample for the next 50 years.

OTHER METALS

GOLD AND SILVER

Production and use. Gold and silver have been produced in NAR, but never in more than small amounts except as byproducts of copper, lead, zinc, and iron mining. Silver production from New York State was reported at nearly 20,000 ounces in 1962 and 13,000 ounces in 1964. Gold and silver are recovered in Pennsylvania as a byproduct of iron ore mining, but output is small. Neither gold nor silver production was water related.

Besides their use in coinage or as monetary reserves, gold and silver are used as an industrial material in the manufacture of jewelry, in dentistry, and for electrical and electronic components. In 1964, almost 75 percent of the 4.8 million troy ounces of gold consumed by the domestic industry was used for jewelry or other artistic purposes. In addition, silver is a constituent of photographic film and also finds applications in medicine, and as a solder and brazing alloy.

Gold deposits as indicated in Figure H-13 are either as native metal or contained in other metallic minerals. Locations of base metals containing gold and silver are not repeated in this section. A review of the principal gold localities is as follows:

Maine--Gold placer deposits are located near Byron and Milton, Oxford County (Basin 4), and near Moscow, Somerset County (Basin 3).

New Hampshire--In Basin 8, deposits of gold in pyrite and quartz veins are located in the Ammonoosuc District near Lisbon, Grafton County. Gold placers are known in Indian Stream, Coos County.

Vermont--Gold placers are in a southwestward extension of the Ammonoosuc District in New Hampshire into Orange and Windsor Counties (Basin 8) as far south as Plymouth.

New York, Massachusetts, Connecticut--Many gold deposits have been reported in the glacial drift in the Adirondack Mountains of New York and in veins in Massachusetts and Connecticut, but few proved to contain more than a trace of metal and none have been worked profitably.

Pennsylvania--Gold and silver are currently being recovered as byproducts of magnetite mining in Berks (Basin 15) and Lebanon Counties (Basin 17).

Maryland--Gold occurs in Montgomery and Carroll Counties in Basin 19.

Virginia--Major occurrence of gold is in the "Gold Pyrite Belt" which extends from southeastern Buckingham County northeastward through Fairfax County in Basins 21, 20, and 19.

Relationship to water. Placer mining of gold by individuals may occur locally but will have little effect on water pollution. Gold and silver production is not considered as water related since almost all output is associated with base metal production and water used by the base metal industries is described elsewhere.

Outlook. Gold and silver production in NAR will probably never be a major industry since all production will occur associated with other base metals. With base metal output increases in the future, production of these precious metals will also have a tendency to increase.

RARE EARTHS AND THORIUM

Production and use. Rare earths are those elements whose atomic number ranges from 57 to 71 (lanthanum to lutetium) on the periodic table. Yttrium, atomic number 39, is usually regarded as a rare earth because of its chemical similarities. More than 200 minerals are known that contain the rare earths and thorium. Monazite and bastnaesite are the principal commercial sources of the rare earths, and monazite is the principal source of thorium. Deposits of monazite and apatite (a mineral source of yttrium and other rare earths) are known in NAR but are not presently mined. However, several companies prepare metals and compounds from concentrates produced outside this Region. These plants are located at Pompton Plains and Newark, N.J.; York and New Castle, Pa.; Carle Place, N.Y.; and Great Barrington, Mass.

The use of rare earth elements, as compounds, metals, and alloys, are divided by importance into the following categories: (1) the glass industry; (2) carbons for arc lighting; (3) metals and alloys; and (4) in miscellaneous applications. Various rare earths are used in the glass industry for polishing, decolorizing, optical filters, and for improving the optical quality of glass. Rare earth fluorides and oxides are used in the cores of arc-light carbons for greater light intensity. Misch metal made from rare earths is used in lighter flints. Other metallurgical applications include use as deoxidizers, desulfurizers, and grain refiners. Miscellaneous uses include the production of chemical compounds and use in the electronic industry.

Monazite has been reported in many localities in NAR. It has been identified in granites from Maine to Virginia, but in most areas it has only been a mineralogical curiosity or a collector's item. Rare earth alkalies containing minerals of rubidium and cesium are found in many of the pegmatites of Maine, New Hampshire, Massachusetts, and Connecticut, indicated in Figure H-8. A belt of monazite, extending through Basins 20 and 21 in Virginia, is known to contain 27 occurrences. Rare earth and monazite deposits in New York, New Jersey, and Virginia are shown in Figure H-8.

The Mineville-Port Henry District in Essex County, N.Y., (Basin 11) is the principal area for deposits of apatite containing a high percentage of rare earths and some thorium. Apatite is found in mine dumps and mill tailings as part of the waste material discarded from magnetite mining. Five deposits or prospects are located in Morris, Sussex, and Warren Counties, N.J., in Basins 14 and 15.

Relationship to water. If rare earths are mined in NAR, water will be needed to beneficiate the ore. The quantity used per ton of mill feed will be on the order of 1000 gallons--comparable to quantities used in flotation plants recovering other minerals. Acid and dissolved solids would not be a pollution hazard and suspended solids would be retained in tailings ponds.

Outlook. Rare earth metals and compounds are expected to be consumed on a slightly increasing scale until 1980. The long range outlook is for a steady growth in consumption with any acceleration being contributed by uses now in the process of development.

The likelihood exists that by the beginning of the next century the processing of ores for the extraction of thorium, required to generate nuclear energy, also will provide byproduct rare earth minerals, including europium, the least abundant rare earth. The demand for europium for use in television phosphor, laser and control-rod material is increasing.

Generally, the advances in technology will result in an overall decrease in processing and refining costs, making the opening and developing of deposits in NAR a greater possibility, especially for those associated with iron ores in New York and New Jersey.

TITANIUM

Production and use. Presently, there are two titanium mining operations in NAR; one each in New York and New Jersey. One operation in Hanover County, Va., discontinued production of rutile and ilmenite in 1968; another in Amherst County, Va., closed down in June 1971. Ilmenite is recovered as a coproduct of magnetite from an open pit mine near Tahawus, N.Y., and from a placer mine in New Jersey. Processing at the New York operation consists of grinding the crude ore and using wet-magnetic separators. The less magnetic fraction containing the ilmenite is sized and concentrated on reciprocating tables. In New Jersey, sand is picked up by suction and pumped to the mill as a slurry. At the mill the slurry is screened and dried, and the ilmenite is separated by magnetic and electrostatic methods.

The principal use for titanium is in the making of titanium dioxide pigment, an important whiting and opacifying ingredient used in paint. In 1934, the United States produced 32,000 tons of this pigment and by 1964, production had risen to 551,000 tons. Titanium had minor use as an alloying element in 1934, but by 1969 production, reported as sponge metal, was about 14,000 tons. The principal uses for titanium metal or alloys are in the aerospace and chemical industries.

Titanium mines which were active in 1964 in Basins 12, 16, and 21 are indicated in Figure H-13. Other deposits in the Region are as follows:

In Vermont, titaniferous deposits are in Orleans County (Basin 11) and Windsor County (Basin 8). Three titanium deposits in Connecticut are in Basin 10; one in Litchfield County and two in New London County. In Basin 9, titanium occurs near Cumberland, R.I.

In addition to the active mine at Tahawus, 11 other deposits and prospects are known in Essex County, N.Y. (Basins 11 and 12). Other deposits in the State are in Westchester and Franklin Counties.

In New Jersey, two deposits each are in Ocean (Basin 16) and Burlington (Basin 15) Counties. Another occurrence in Basin 15 consists of a titaniferous outcrop near Durham, Bucks County, Pa. Two placer deposits are in Cecil and Worcester Counties, Md. (Basin 18). Several deposits are in Basin 18 in Virginia.

Relationship to water. The quantity of water used in mining and beneficiating titanium ores depends on the type of mine and mill. In NAR, the active open pit mine uses more water for milling than in mining. Water used by these mills is obtained from lakes, rivers, or wells, and the supply is adequate for the present. Water used in the open pit mines to control dust during drilling is not recoverable but the loss is negligible. There is no rock drilling at the placer mine but prospecting for additional ore is accomplished by water jet drilling; water loss is minor.

Seventy percent of the water used in processing ore at the mine and mill in New York is obtained from mine drainage, the balance is from Sanford Lake. Eighty-six percent of the water is discharged untreated into surface channels from the tailings pond. Present supply of water is reported to be adequate.

Water used by the plant in New Jersey is primarily for transporting the ore to the initial screening process and is obtained from two wells. The company reports the supply is adequate for the present and if necessary for additional supply, a third well is available. Nearly 50 percent of the total water used is recirculated and discharged water is treated by settling.

The quality of water required at these mines and mills, at the present, is not critical. However, treatment of recirculated water to eliminate solids is necessary for use in rock drilling operations. Water is used to transport the ore at the placer operation and only settling is necessary to remove solids before reuse or discharge into surface channels.

Water supply for this industry, at the present rate of production, is adequate and additional water is available for anticipated increased requirements. The New York State mine has an additional supply of water available from a nearby lake. The Virginia mine could recirculate water to eliminate a possible shortage of new water. Waste water is treated to remove suspended solids before being discharged.

Outlook. Titanium resources in rock are far greater than those in placer deposits. However, about half the present output comes from placers. This relationship of sources probably will continue for many years since the quality of concentrate recovered from sand is high and mining costs are low. The long-range outlook is toward fuller utilization of the more plentiful rock deposits.

Requirements for all uses of titanium in the United States by the year 2000 will range between 1.1 million and 2.6 million tons. Continued growth in the use of titanium dioxide pigment will contribute to the demand range for titanium in 2000. Demand for the metal for chemical processing and aerospace applications is expected to increase at a much faster rate than for the pigment, and by the year 2000 may constitute up to a third of the total demand as compared with only 4 percent in 1968.

Water supply is adequate to support increased production at most plants but use of recirculated water may be necessary. Anticipated expansion of this industry need cause no water pollution problem because suspended solids are removed by settling and most flotation reagents are biodegradable.