

Geologic Resource Assessments Subactivity

Subactivity	FY 2000 Estimate	Uncontrol. & Related Changes	Program Changes	FY 2001 Budget Request	Change from FY 2000
Mineral Resources	53,893	+1,193	-2,000	53,086	-807
Energy Resources	22,783	+524	⁽¹⁾ -2,009	21,298	-1,485
Total Requirements \$000	76,676	+1,717	-4,009	74,384	-2,292

¹ See Program Change section for details on C/FIP (+\$500) and program decreases (-\$2,509)

Energy Resources

Current Program Highlights

Our Nation faces the simultaneous challenges of an expanding energy appetite, an increasing dependence on imported oil, and an increasing demand for energy that produces minimal environmental effects. The USGS Energy Resources Program (ERP) addresses these challenges by conducting basic and applied research on geologic energy resources and on the environmental and economic impacts of their extraction and use. The program provides reliable, impartial, scientific information and comprehensive analyses of oil, natural gas, and coal resources of the Nation and the World. Major consumers of our products are the land and resource management bureaus of the Department of the Interior, federal environmental and national security agencies, State geological surveys, the energy industry, and the environmental community.

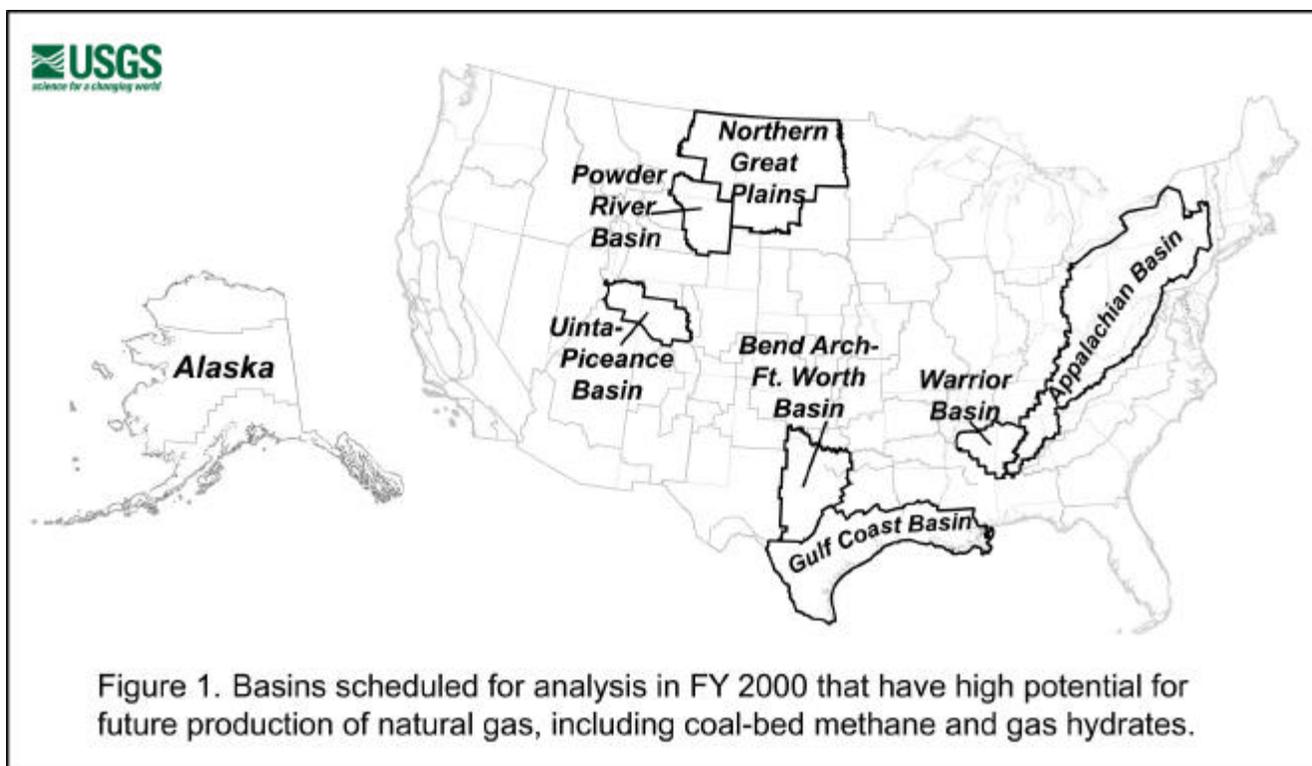
Future Energy Resource Availability -- The Energy Information Administration (EIA) Annual Energy Outlook 2000 forecasts that worldwide energy consumption will increase 27% between 1998 and 2020 due to growth of the world economy. In the United States, forecasts indicate that natural gas consumption will increase 40%, coal consumption will increase 20%, and petroleum demand will grow 29%, in part, due to a predicted 60% decline in nuclear electricity generation capacity.

The Energy Resources Program conducts periodic assessments of all major energy resources. The National Coal Resource Assessment (to be released in FY2000) will report on the quantity, the availability, and the recoverability of coal that will provide the bulk of the Nation's supply for the next two or three decades. The National Oil and Gas Assessment (to be released in FY2004) will focus on those regions of the Nation that have the greatest potential for undiscovered gas resources vital to meet the increasing demand for natural gas as a substitute for oil and coal. The World Energy Assessment (to be released in FY2000) will assess the 76 most productive oil and gas provinces of the world that contain about 95% of the world's oil and gas resources. A challenge in oil and gas assessment activities is a better understanding of the geologic, technologic, and societal controls on reserve growth, the primary source of future oil supplies in this country.

National Oil and Gas Resources -- The 1995 USGS National Oil and Gas Assessment concluded that the probability is low that many more significant oil reservoirs will be discovered

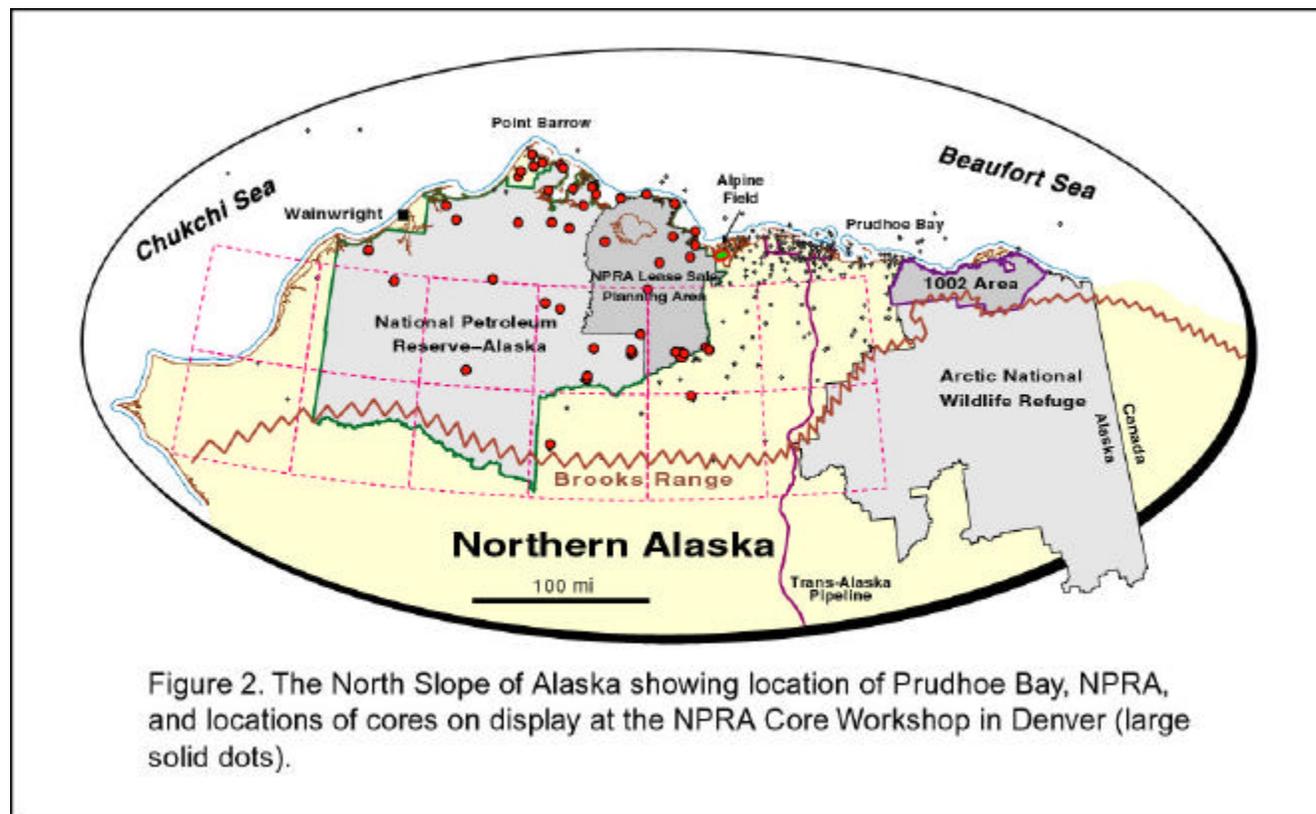
in the onshore areas and state waters of the United States. Instead, our remaining energy supply will come from natural gas deposits, from existing oil and gas fields, and from imports. Additionally, the 1990 Clean Air Act Amendments, and concern about greenhouse gas emissions to the atmosphere, have introduced a sense of urgency to identify the Nation's remaining deposits of natural gas, the cleanest burning fossil fuel. Consequently, the USGS has initiated a new national assessment that focuses on the Nation's natural gas endowment and the potential of additional reserves of oil and gas from existing fields in the United States, exclusive of Federal waters.

Research starting in FY00 and continuing to FY04 will focus on regions of the Nation that have high potential for future production of natural gas, including coal-bed methane and gas hydrates, and on the scientific challenge of improving the accuracy of natural gas resource assessments. This effort begins in the Uinta-Piceance region of Colorado and Utah; the Northern Great Plains region encompassing parts of Montana, North Dakota, and South Dakota; the Powder River Basin of Wyoming and Montana; the Bend-Arch/Fort Worth Basin of Texas; the Black Warrior Basin of Alabama; the Appalachian region, primarily in Ohio and Pennsylvania; the onshore Gulf Coast region, specifically in Texas and Louisiana; and Central Alaska (figure 1). Additional basins will be included based on regional priorities identified during the assessment. The North Slope of Alaska and the Gulf Coast region hold the most promise for new oil and gas discoveries in this country.



Alaska -- The North Slope of Alaska is thought to have the greatest remaining oil potential of any onshore area in the United States; the USGS is conducting an intensive examination of its geology and petroleum potential. The current research focus is the National Petroleum Reserve – Alaska (NPR) on the western portion of the North Slope (figure 2). Activities in Alaska include petroleum geologic framework of the NPR; evaluation of the resource potential of gas hydrates in northern Alaska; evaluation of coal-bed methane as a local energy source for

the native villages of Chignik, Fort Yukon, and Wainwright; and Cook Inlet petroleum reservoir and coal studies. These studies are collaborative efforts with the Alaska Division of Geologic and Geophysical Surveys.



The Energy Resources Program is preserving and archiving Alaskan oil and gas datasets compiled during two government oil and gas exploration programs in the NPRA; one by the U.S. Navy in the 1940s and 1950s and the other by the Navy and the USGS in the 1970s and 1980s. More than 14,000 miles of seismic and related geophysical data, logs and other records from 126 drill holes, and special studies of geochemistry, paleontology, and reservoir rocks are being transferred to more durable and accessible digital formats from aging tape media. The USGS is working cooperatively with the Bureau of Land Management, USDA Forest Service, and Alaska Division of Geological and Geophysical Surveys in this effort.

Gulf Coast Region -- In the Gulf Coast region, the USGS is developing a geologic framework of the oil- and gas-bearing rocks of Texas and Louisiana using seismic data. This framework will allow USGS scientists to better assess the potential for undiscovered resources and to define potential assessment plays that are onshore extensions of plays identified by the Minerals Management Service for offshore Federal resources. The USGS is examining the petroleum potential of the Austin Chalk trend, our Nation's largest onshore domestic unconventional oil resource; the deep gas reservoirs of the Tuscaloosa Formation, one of the major gas producing formations in the Gulf Coast Region; and the coal-bed methane producing potential of the extensive lignites of Texas, Louisiana, Mississippi, and Alabama (figure 3).

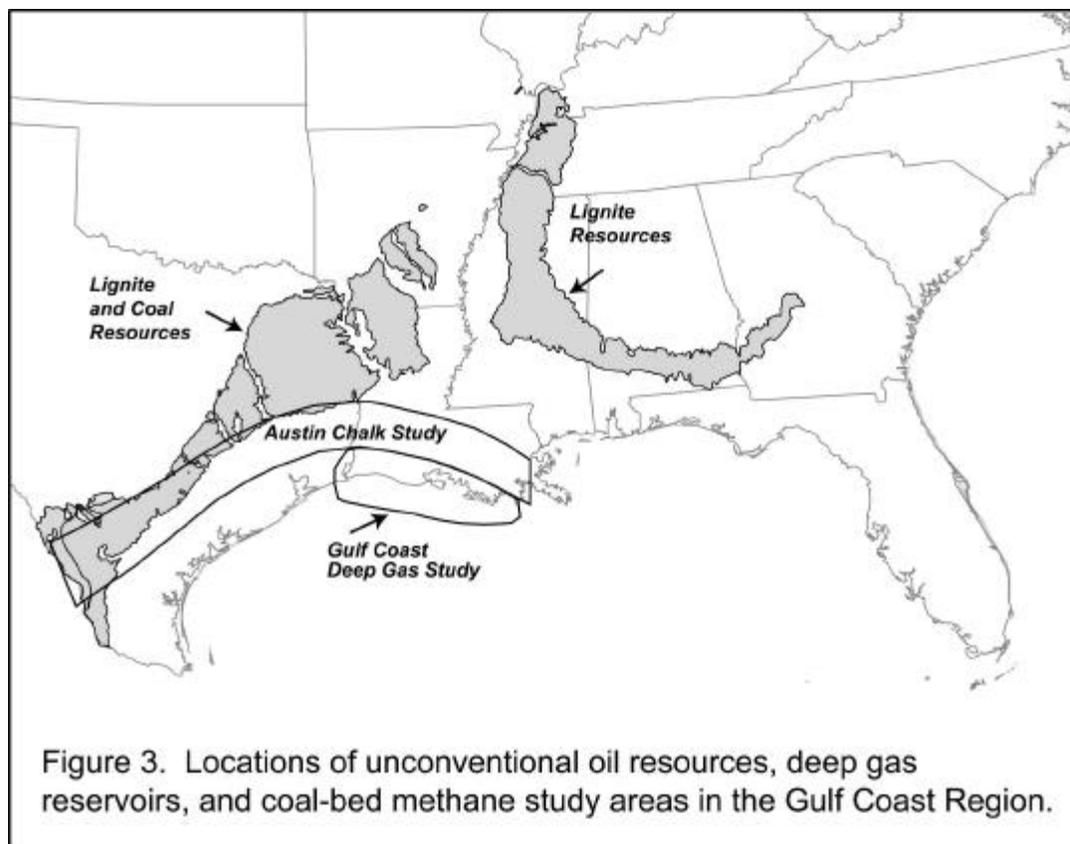


Figure 3. Locations of unconventional oil resources, deep gas reservoirs, and coal-bed methane study areas in the Gulf Coast Region.

National Coal Resources -- The USGS is assessing coal resources for use in the first quarter of the 21st century. This intensive, multi-year assessment of the quantity, quality, availability, and recoverability of coal involves the generation of digital databases and use of geographic information system (GIS) technology to facilitate quantitative estimation of coal resources. The results will be used by Federal and State land managers to support land-use decision-making, by environmental regulators to evaluate compliance with regulations stemming from the 1990 Amendments to the Clean Air Act, and by economists to forecast economic trends at regional and national scales. Electric utilities, coal producers, and coal consumers also will use these results and products for evaluating the availability and quality of coal feedstock to electricity generating power plants and to achieve compliance with emission standards and other environmental regulations. The comprehensive summary of coal resources is scheduled for release in FY 2000, although reports on individual regions are being released as they are completed.

This study will form the basis for addressing the challenge of future changes in the energy mix as the Nation responds to increasing demands for cleaner burning coal. Upon completion of the national assessment, the USGS will focus on integrating this new digital resource information with national and global digital inventories of coal quality. The resulting integrated database will allow the USGS to provide critical information to land and resource managers who will manage the Nation's ever increasing need for energy while protecting the environment and human health.

World Oil and Gas Resources -- Worldwide petroleum demand is predicted to increase 27% over the next 20 years, with 70% of that increase due to transportation demands. In the United

States, despite advances in oil exploration and production technology, oil production is predicted to decline about 0.8% per year over the next 20 years. Falling production and rising demand will necessitate an increase in petroleum imports. Currently, net imports account for more than 50% of the U.S. petroleum consumption and are predicted to increase to 64% in 20 years. Consequently, it is in the Nation's interest to know the distribution and quantity of the remaining oil, natural gas and natural gas liquids remaining in the petroleum provinces of the world.

The USGS is assessing undiscovered oil and gas in the most productive petroleum provinces of the world. This current assessment will be the first of its kind to include a rigorous geologic foundation for remaining resource volumes, and the first to make those data available to the entire geoscience, business, and research community. Assisting us in this effort are the U.S. Departments of Energy, Defense, and State; U.S. Agency for International Development; Energy Information Administration; International Energy Agency; the intelligence community; and over two dozen industry partners.

To-date, seven CD-ROM's have been released that describe and rank selected petroleum provinces and contain digital geologic maps for those provinces. More than 25,000 copies have been distributed in response to requests received at professional meetings, by mail, and via the WEB. The complete assessment will be released at the World Petroleum Congress in June 2000 in Calgary, Alberta. The next phase of the World Assessment will focus on global unconventional gas resources in anticipation of advances in gas-to-liquids technology and the future availability of those liquids for export.

Energy Resources and the Environment -- Carbon emissions (primarily as carbon dioxide) from energy use are projected to increase 20% by 2020. Eighty-two percent of carbon emissions associated with the use of petroleum products result from the transportation sector. Electricity generation will account for 38% of all carbon emissions. Coal is the predominant fuel source for electricity generation and is the second leading fuel source of carbon emissions, due to its high carbon content. Use of natural gas, with just half the carbon content of coal, should outpace all of the fossil fuels.

Additional environmental challenges addressed by the Energy Resources Program are the disposal of hazardous oilfield waters that are co-produced with oil and gas, coastal subsidence due to reservoir depletion, and the introduction of sulfuric acid into surface and groundwater from leaching of sulfur-bearing minerals in the overburden produced in coal mining.

Coal Quality and Human Health -- Currently, over half of the Nation's electricity is generated by burning coal and the demand for electricity will continue to increase. Coal combustion produces a wide range of potentially hazardous substances that impact the environment. The Energy Resources Program supports research to understand the natural variability of coal quality and the environmental and human health impacts of mining and utilization of coal as an energy source. This research provides objective scientific information to guide private industry and federal and state policy-makers.

The USGS National Coal Quality Inventory (NaCQI), a database of the chemistry of coals used in power plants, has recently been established and will expand through collaboration with State geological surveys and the Electric Power Research Institute. The database will continue to grow by adding new data about the coal that we anticipate will be mined in each region of the United States during the coming decade. These digital data will enable Federal and State regulatory agencies, electric power utilities, and the coal industry to quickly access and display

detailed coal quality information to address air quality issues and to maintain compliance with the 1990 Amendments to the Clean Air Act. NaCQI also will be a valuable scientific tool for evaluating the feasibility of achieving CO₂ and other greenhouse gases emission targets.

Through its coal quality research effort, the Energy Resources Program provides EPA and DOE with reliable estimates of amount and behavior of hazardous elements, such as mercury and arsenic, in the coal mined in this country. Additionally, the USGS is compiling a database of coal quality from around the world, the World Coal Quality Inventory (WoCQI), to provide information for policy makers to evaluate the environmental impacts of global coal use.

CO₂ Sequestration -- The USGS is assessing the capability of depleted oil and gas reservoirs and unmineable coal beds to accept and sequester carbon dioxide produced by power plants. This research effort will provide forecasts of the amount of carbon dioxide, other greenhouse gases, and hazardous chemical atmospheric emissions based on current and projected energy consumption of the Nation and the World. Additionally, the research will include evaluations of energy supply reliability and economic impacts of various mitigation scenarios for reducing carbon dioxide and other greenhouse gas emissions. Assessment results will provide policy makers with a basis for evaluating technologies that reduce carbon dioxide emissions to the atmosphere.

This effort will provide fundamentally new information on the capacity of geologic reservoirs to serve as long-term repositories for carbon dioxide. If the methodology for quantitative assessment of total repository capacity is successful, it will be applied on a worldwide scale, allowing international assessment of carbon sequestration capacity.

Disseminating Energy Resource Information

Geo-Data Explorer – GEODE -- The wise stewardship of federally managed lands requires detailed knowledge of domestic energy-resource availability, quality, and distribution. The ability to integrate that resource knowledge with other environmental or land-use information is becoming increasingly important. Because Federally managed lands contain a large proportion of the remaining energy resources of the U.S., it is important that land-use decisions concerning energy-resource development be made within the context of the energy-resource endowment and energy-mix goals of the Nation.

Consequently, the Energy Resources Program has developed an energy resource decision support system, called Geo-Data Explorer, or GEODE. This unique software is a GIS-based, WEB-accessed, interactive data delivery system of energy, cultural, and environmental information that is specifically designed to assist land and resource managers and to facilitate integrated energy research within the USGS. The system can be accessed at <http://geode.usgs.gov/>. In addition, energy databases are maintained and available from the USGS at: <http://energy.usgs.gov>.

Recent Accomplishments

The USGS, through its Energy Resources Program, conducts energy resource assessments of coal, oil, and natural gas throughout the Nation and the world. Major products are expected in FY2000 from the National Coal Resource Assessment and the World Energy Resource Assessment projects. The USGS assisted the Department of Interior in its recent lease sale in

Alaska, progress has been made in understanding the natural variability of coal used in power plants and in the resource potential of permafrost gas hydrates, and we have made significant advances in our ability to deliver our digital data over the internet.

National Oil and Gas Assessment

National Petroleum Reserve-Alaska – The USGS is focusing on the National Petroleum Reserve-Alaska (NPRO) to conduct an assessment similar to the oil and gas assessment of the 1002 area of the Arctic National Wildlife Refuge. In May of 1999, the Department of the Interior conducted a lease sale in the NPRO, which was the first Federal petroleum lease sale on the North Slope of Alaska since 1984. In support of that lease sale, the USGS held a Core Workshop in March 1999 to allow various stakeholders and representatives of industry to examine rock samples from the NPRO at the USGS Core Research Center in Denver, Colorado (see figure 2). The workshop attracted scientists from industry and state and federal agencies, and was co-sponsored by the Petroleum Technology Transfer Council (PTTC). A CD-ROM (Open-File Report 99-015) was produced as a result of the workshop and provides geologic data and core photographs from 11 NPRO wells. Additionally, USGS scientists working in the eastern NPRO in FY1999 discovered a surface outcrop of an oil-stained formation, which has been interpreted as an exhumed oil accumulation that may have originally held more than one billion barrels of oil. This discovery will assist scientists in estimating the volume of undiscovered oil and gas yet to be found on the North Slope.

Gas hydrates-North Slope -- There is significant potential that large volumes of methane gas are stored within the permafrost of the North Slope in ice-like structures known as gas hydrates. Gas hydrates may prove to be a major source of clean-burning methane for the Nation. However, there has been little success in producing this resource due to technological challenges. The USGS is working to assess the recoverability, resource potential, environmental effects, and production characteristics of permafrost-associated natural gas hydrates with support from the U.S. Department of Energy (DOE) and industry operators in Alaska.

In 1998, researchers from Japan, Canada, and the USGS undertook the first extensive investigation of a natural gas hydrate accumulation in an Arctic Basin by drilling the Mallik 2L-38 gas hydrate research well in the Mackenzie Delta of Canada. The results of that study have recently been released in the Geological Survey of Canada Bulletin 544. This international report provides a multi-disciplinary overview of the nature and occurrence of gas hydrate in the Mallik well. The results of this research effort in Canada have provided the critical foundation for the next phase of USGS research into gas hydrates in permafrost near Prudhoe Bay on the North Slope of Alaska (see figure 2). USGS scientists are collaborating with scientists from DOE and private industry.

National Coal Resource Assessment -- The National Coal Resource Assessment of the top five coal-producing regions of the Nation will be released in FY 2000. These regions include the Appalachians, the Gulf Coast, the Illinois Basin, the Northern Rocky Mountains and Great Plains, and the Colorado Plateau. The assessment of coal resources of the Northern Rocky Mountains and Great Plains Region is now available on CD-ROM as USGS Professional Paper 1625-A and Open-File Report 99-376. Coal resource assessments of the other four regions will be released during FY2000. This five-year study is the first to use digital techniques for estimating the coal resources that this nation will need for power generation over the next 30 years; the assessment includes information about coal quantity, quality, availability, and recoverability. The National Coal Resource Assessment will form the essential framework for

the first USGS National Coal Quality Assessment, to be initiated in FY 2002, which will provide the Nation with crucial information on the availability and recoverability of Phase II compliant coals, in accordance with the 1990 Clean Air Act Amendments.

World Oil and Gas Assessment -- The USGS World Energy Assessment Project released five interim CD-ROM publications in 1999 that contain geologic maps and petroleum provinces for five oil and gas regions of the world: the Arabian Peninsula, South Asia, the Former Soviet Union, the Asia Pacific Region, and a proprietary study for the intelligence community. Two CD-ROMs were released in 1998, a ranking of the petroleum provinces of the world and the petroleum provinces of Sub-Saharan Africa. Each of these products has been well received by domestic and international stakeholders with more than 25,000 copies requested and distributed thus far. USGS scientists have developed a sophisticated probabilistic assessment method that has been endorsed by the American Association of Petroleum Geologists. This USGS effort has been profiled in a nationally distributed video prepared by the American Geological Institute and the USGS, and project scientists have made presentations in numerous public forums concerned with the potential of an impending global oil crisis. The preliminary results of this study are being used by Department of State, Department of Defense, and the intelligence community as fundamental input for analysis and development of foreign policy and domestic energy policy. Additionally, a cooperative agreement is being established between the USGS and the International Energy Agency, Paris, to conduct collaborative research with scientists working on this World Assessment.

Hazardous Elements in Coal -- The focus of USGS coal quality research is in coal-producing regions that have reported potentially toxic concentrations of hazardous elements in coal. Recent analyses of coal samples collected from active and abandoned mines in the Warrior Basin, Alabama, indicate elevated concentrations of as much as 4800 ppm of arsenic, 20 ppm of mercury, and 100 ppm of thallium. These findings will be used in an engineering model to predict toxic element emissions from coal-fired power plants. If this model gains wide acceptance, it will have important ramifications for the electric power industry in the next century.

The EPA continues to use the NaCQI coal quality database for guidance to establish realistic compliance standards mandated by the 1990 Clean Air Act Amendments. In particular, EPA has used USGS data on mercury in coal to estimate the total load of mercury contributed per year by the combustion of coal in the U.S. and to review a recent Information Collection Request (ICR) for mercury and chlorine in U.S. coals.

Energy Decision Support: Geo-Data Explorer -- In FY99, the Energy Resources Program introduced its energy resource data delivery system, Geo-Data Explorer (GEODE), to the public via the Internet at <http://geode.usgs.gov/>. This web site is designed to provide both non-technical and scientific users quick access to the scientifically sound, unbiased energy resource data produced by the USGS, by providing them with real GIS tools over the Internet, an unprecedented capability that previously had been unavailable. Users can access complex energy datasets in a map format, make queries of data details, and superimpose energy and environmental data layers to create their own unique maps, for their specific needs, using just their web browsers. This new tool will enable Federal and State land managers to conduct sophisticated analyses at their desktops without requiring complex software or GIS expertise.

NRC Review of the USGS Energy Resources Program -- The National Research Council (NRC) of the National Academy of Sciences reviewed the Energy Resources Program in 1999. In their report, *Meeting U.S. Energy Resource Needs, The Energy Resources Program of the*

Geologic Resource Assessments Subactivity

U.S. Geological Survey, the NRC acknowledges the unique and critical role that the Energy Resources Program plays in providing up-to-date and impartial assessments of geologically based energy resources of the Nation and the World. The NRC panel encourages the USGS, through its Energy Resources Program to continue supporting a strong research and knowledge base to understand the origin and recoverability of fossil energy resources and to assess the future availability and environmental consequences of developing energy resources.