Productive Capacity Indicator 2: Exploration activity over time

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Summary

Assessment of exploration activity in the United States is important for understanding our ability to supply resources to meet future needs. Because there is a long lag time, typically 5 to 15 years or even longer (if development occurs at all), between the time a mineral deposit is discovered and the time it reaches production status, it is important to look at long-term trends in both worldwide and domestic exploration activities to evaluate whether current exploration activities may be sufficient to generate future mineral supply on a timely basis.

For some mineral commodities, particularly industrial minerals or metallic deposits in districts heavily explored prior to the last decade (such as copper in the southwestern United States), resources sufficient to meet forecasted demand for many years already have been identified by prior exploration. The lack of current exploration in these districts may not suggest lack of interest for future exploration. Mineral exploration generally focuses on those commodities that are more sensitive for supply disruption (platinum-group metals, tin) or have a high value per unit weight revenue potential (gold). Consequently, some mineral exploration is time dependent, meaning it depends upon current social, political, or economic factors. Precious metals, particularly gold, have been the dominant mineral targets for the entire study period (1980-2001). Since the mid 1990s, gold has accounted for 45-65 percent of nonfuel mineral exploration budgets. Base metals accounted for 25-40 percent of exploration activity, and diamond exploration accounted for about 5-10 percent. Data reported below for nonfuel mineral exploration activity relate primarily to these mineral commodities.

The search for energy minerals in the United States is closely tied to their strategic importance to domestic supply and international energy prices. As U.S. import reliance on foreign sources (some of which are located in areas where supply disruptions are possible) grows, the strategic importance of domestic sources also grows. Consequently, energy exploration activity is often the highest during periods of actual or anticipated supply disruption and/or high energy prices. Several indicators of energy exploration activity are included; and all show a similar pattern of change.

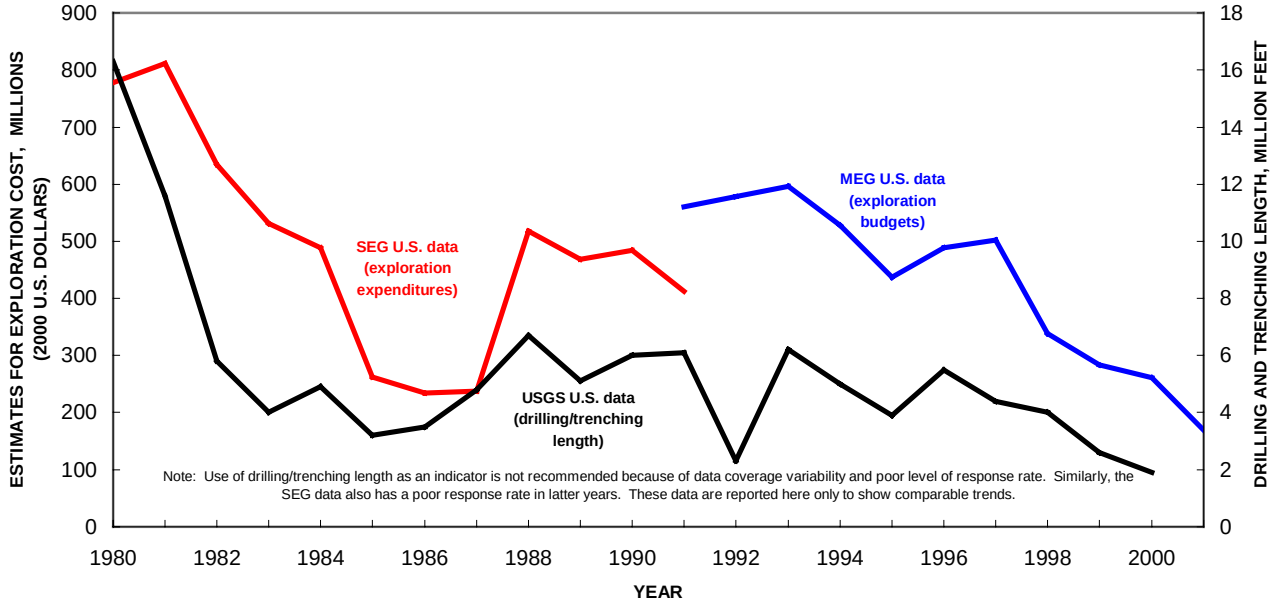
Indicators have been prepared for both nonfuel minerals (metals and industrial minerals) and energy minerals (coal, oil and gas, and uranium). Exploration techniques and mining methods can be very different for these types of natural resources. Energy-related mineral exploration statistics are more readily available. Statistics compiled from different sources vary slightly, but show similar trends.

The last decade has brought about many changes that have affected natural resource exploration. Technological advances in geophysics and remote sensing have led to less drilling and sampling. Industry consolidation and tighter exploration

budgets have led to fewer test drilling programs. As mineral target types change, so do exploration methods and expenditures. The search for copper porphyries requires different prospecting techniques than the search for veined copper; similarly, Carlin-type gold exploration requires a different approach than the search for placer or veined gold. Reliance on sophisticated geologic modeling and geochemical and geophysical techniques have improved detection capability while increasing regional exploration costs, and have been increasingly influential in focusing drilling activity. Because of the varied and changing structure of resource exploration, indicators accurately reflecting this structure over time must therefore be chosen carefully, and multiple indicators may be necessary.

Potential indicators have been developed and summaries are given in figures 1 and 2, for years in which data are available. Discussions of indicator strengths and weaknesses are also included in attached appendices. Figure 1 summarizes data for two nonfuel mineral indicators, annual exploration dollar expenditures/budget estimates and annual drilling and trenching length. While there are significant weaknesses to both sets of data, which may limit their use as an indicator of exploration activity, they both show similar trends for the timeframe where data are available. Ultimately, tracking the quantity or value of mineral discoveries per effort expended would be more meaningful. However, data of this type are unavailable, nonexistent, or difficult to compile for nonfuel minerals. An indicator of this type, however, has been developed for oil and gas resources.

Figure 1. - Summary of nonfuel mineral exploration data.



Sources: Metals Economics Group, Society of Economic Geologists, U.S. Geological Survey
Approximately 45-65% of reported nonfuel mineral exploration is for gold, 25-40% for base metals, and 5-10% for diamond.
SEG and MEG data adjusted to account for changes in survey coverage.

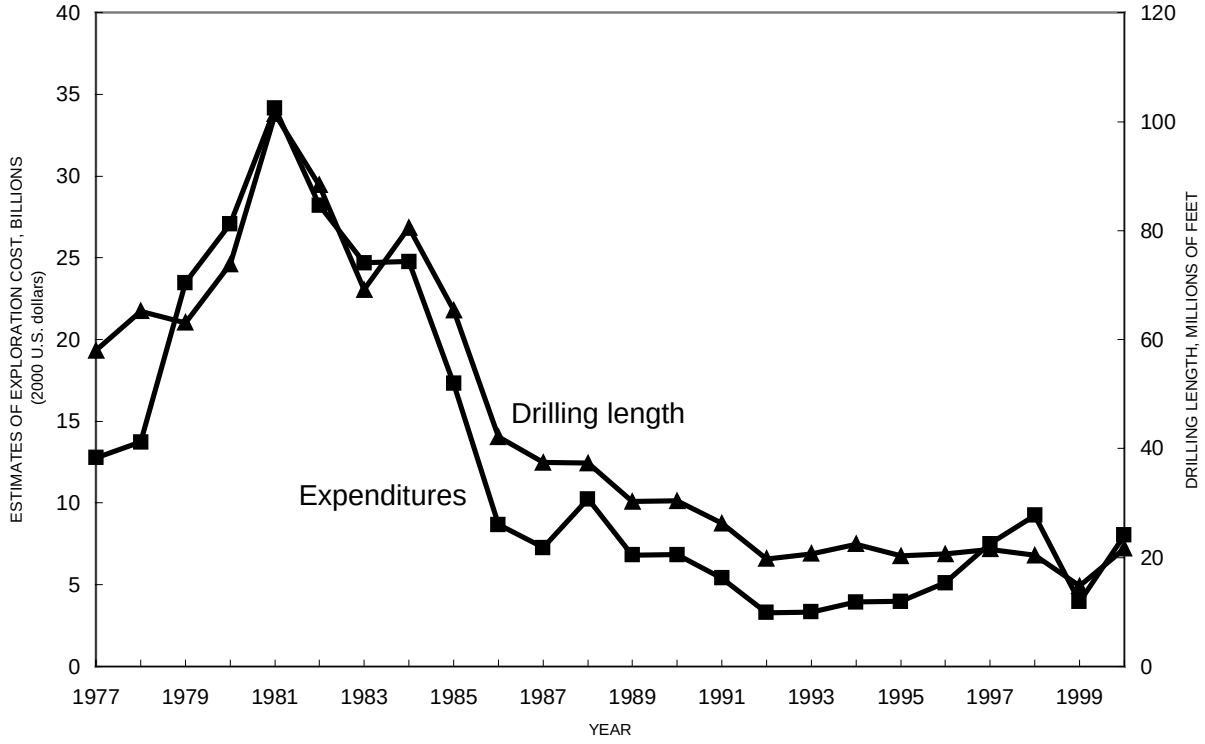
Nonfuel minerals:

Based on evaluated data for the past 22 years, similar trends were observed from the two nonfuel mineral indicators. It appears that U.S. nonfuel minerals exploration peaked around 1980-81, but has fallen since then. Fluctuating commodity prices and exchange rates, adequate mineral supply and ample capacity of key commodities, and changing global economic conditions all affected exploration activity during this period. The exploration data trend appears to reflect the trend of the price of gold (the principal mineral target), but lags its peaks and valleys by about 1 year. Between 1986-97, the level of exploration activity appears to have remained relatively stable (except for a dip in exploration drilling during 1992, perhaps the result of anticipated changes in mining laws), after which the combined effects of continued low mineral prices, efforts for environmental regulation, and revised mining claim laws on public lands affected domestic mineral exploration. Domestic exploration activity, as measured by both indicators, shows that current levels are at their lowest levels for the time period considered.

Energy minerals and fuels:

Figure 2 summarizes similar data for the domestic oil and gas industry. The two indicators, annual exploration dollar expenditures and annual drilling length, appear to reflect similar data trends. Both indicators appear to be closely linked to fluctuations in the cost to purchase crude oil since about 1970. Both exploration indicators peaked between 1979 and 1985, in response to increased demand for domestic energy sources brought about by energy shortages of the late 1970s and resulting higher energy costs. The U.S. Department of Energy was created in 1977, in part to ensure that an adequate domestic supply of energy resources was maintained. Since its creation, the Department, through its Energy Information Administration, has compiled publicly available statistics that have been used to develop the two indicators shown in figure 2.

Figure 2. - Summary of selected oil and gas exploration data.



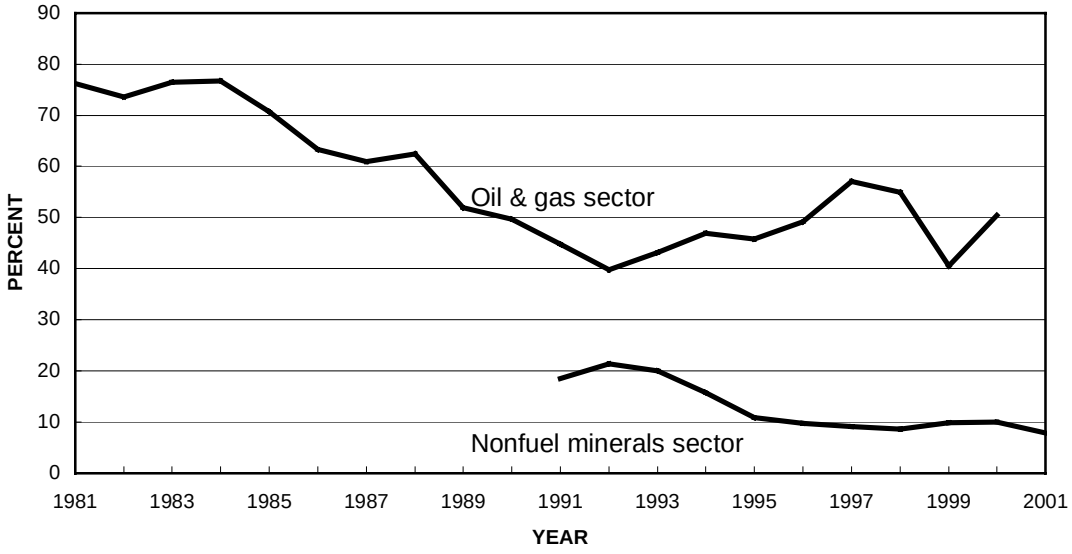
Drilling data for the uranium industry are also available. These data have been included as part of Appendix 2.2.2. Public coal exploration leasing and licensing data are reported in Appendix 2.2.5.

Link to International Data:

Reporting U.S. exploration activity by itself can be misleading if it is not linked to world exploration activity. The mining and energy sectors are increasingly becoming more global, as U.S. and foreign exploration companies consolidate. Sustainability is an international issue. Therefore, it is recommended that indicators of both U.S. and world exploration activity be reported. Figure 3 shows that the U.S. percentage share of the world exploration budget has dropped to the lowest level in at least a decade, as U.S. nonfuel mineral exploration companies have transferred larger percentages of their exploration finances overseas. The energy sector also saw significant consolidation and globalization after the energy crisis of the late-1970s. As a result, the domestic share of oil and gas exploration dropped significantly between 1985 and 1992. It is significant to note, however, that the U.S. share of oil and gas exploration

and development has remained relatively stable (or increased slightly) at about 48 percent of world expenditures since about 1990, while the U.S. share of nonfuel minerals exploration has tended to decrease slightly during this period.

Figure 3. - Summary of the U.S. share of world exploration expenditures for selected natural resource sectors.



Sources: U.S. Department of Energy, Energy Information Administration, Metals Economics Group

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APPENDIX

INDICATOR 2.1 ANNUAL DRILLING LENGTH

DATA COVERAGE: Nonfuel minerals, oil and gas, and uranium
DATA UNITS: Million feet
DATA SOURCES: U.S. Department of the Interior, U.S. Bureau of Mines (1958-1994)
U.S. Department of the Interior, U.S. Geological Survey (1995-PRESENT)
U.S. Department of Energy, Energy Information Administration

The use of drilling length data as an indicator of exploration activity may be a good indicator for a natural resource sector such as oil and gas, where drilling is a major exploration method and data are readily available and consistent. It is a much poorer indicator in the nonfuel minerals sector, however, where drilling may not be required in certain geological environments, where drilling represents a single component of the exploration process, and available data is less reliable because of poor survey response rates. While exploratory drilling data for the nonfuel minerals sector are included in figure 4, it is recommended that they not be considered for use as an indicator for this sector for the reasons discussed here.

Because drilling represents only one part of the exploration process, quantification of drilling length can at best be a proxy for exploration. Such an indicator would not include early exploration activities such as mapping or sampling (which typically are lower cost), or geophysical surveys (which has evolved to become a much more important and expensive exploration tool than in the past and could result in reduced drilling). Work at prospects not deemed worthy of drilling would be excluded from consideration. For many mineral commodities, drilling occurs in the latter stages of exploration, for others, drilling may not be necessary. Drilling activity generally increases after a potential ore body has been identified and is being delineated. Drilling tends to become more expensive for deeper ore bodies, and it generally requires access, permitting, and environmental assessment.

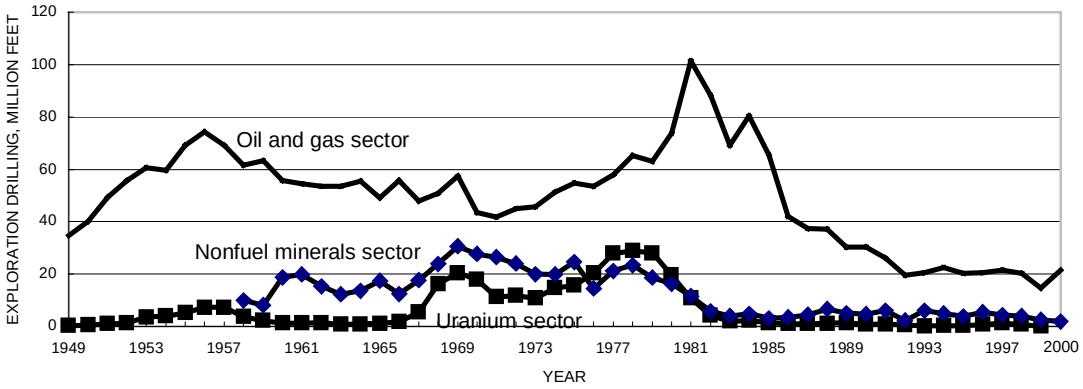
The reliability of drilling length data as an indicator is tied to the completeness of industry surveys used to collect these data. Although annual U.S. nonfuel minerals industry drilling length data are reported by the U.S. Geological Survey (USGS), the coverage rates of available data have declined in recent years and may not be representative. International nonfuel minerals drilling data is available only for a few countries (for parts of Australia, Canada, and the United States) and is usually only reported for high demand nonfuel mineral commodities such as gold and base metals. Domestic drilling data for nonfuel minerals, as reported, are most likely conservative estimates, and a comparison of domestic drilling data with world data is not possible.

The USGS compiles annual nonfuel mineral drilling data from voluntary industry survey responses. Reported data have been published annually in the Mining and Quarrying Trends chapter of the Minerals Yearbook series since 1960 covering data since 1958. Because response rates vary and have generally decreased over time, reported data at best are likely to be conservative, and at worst are inconsistent and

inaccurate. Tabulated totals for churn drilling, diamond drilling, percussion drilling, rotary and reverse circulation drilling, and other drilling and trenching are reported. For most years, trenching accounted for less than 1 percent of the reported total. Prior to 1995, data for several types of development drilling were reported separately, but these data have not been included as part of this indicator. As defined by the survey canvass forms, exploration is work performed in searching for mineral deposits. Development has been defined as work performed in preparing a proven ore body for production, so while it is not part of exploration, development drilling may contribute to ore body delineation or expansion of resources. Development drilling has been excluded from the data shown in figure 4.

The Energy Information Administration of the U.S. Department of Energy collects monthly data on energy minerals exploration and drilling from industry canvass forms, and reports such data to Congress annually. Data are published annually in the Annual Energy Review, and are available on the World Wide Web at http://www.eia.doe.gov/aer/. Tabulated totals for oil and gas exploratory wells, oil and gas development wells, and uranium exploration and development drilling are reported. Drilling is a very significant component in the oil and gas exploration process. Unlike the nonfuel minerals data, the U.S. Government mandates the reporting of oil and gas data from the largest energy-producing companies. Consequently, it is believed that the compiled oil and gas drilling data are a much more accurate representation of the exploration activity within this industry.

Figure 4. - U.S. exploration activity for selected natural resource sectors during the period 1949-2000, expressed by drilling length.



Sources: U.S. Department of Energy, Energy Information Administration; U.S. Department of the Interior, U.S. Geological Survey

Development or production drilling data are not included, unless the data are part of an aggregated estimate and cannot be separated, as in the case of uranium drilling data. For the oil and gas industry, development drilling is considered an integral part

of energy resource extraction rather than exploration, so was excluded from this indicator. Development drilling accounts for the majority of total oil and gas drilling, ranging from 69-87 percent of the total drilling length for oil and gas during the timeframe in which data are reported.

As shown in figure 4, peaks in oil and gas exploration drilling occurred in the early 1980s as a result of extensive exploration drilling on the North Slope of Alaska. Since the early 1980s, domestic exploratory drilling for oil and gas has declined because North Slope oil has since been developed and because of increasing concern for environmental protection and the resulting U.S. Government regulation. Drilling data for 1999 suggests that exploration drilling in the oil and gas sector is at its lowest level for the entire period under consideration, possibly reflecting low energy prices.

Figure 4 also shows exploration drilling trends for the domestic uranium sector. Drilling for this industry peaked in 1969 and again in 1978, reflecting the growth of the nuclear power industry during this period. Increased regulation of the nuclear energy industry in the early 1980s impacted subsequent uranium exploration, such that it declined significantly after 1979. Since 1985, the amount of drilling annually conducted in this sector has dropped below the 2 million foot level.

INDICATOR 2.2 ANNUAL AMOUNT BUDGETED FOR EXPLORATION

DATA COVERAGE: Nonfuel minerals, oil and gas
DATA UNITS: Million U.S. dollars (constant dollars, base year 2000)
DATA SOURCES: Society of Economic Geologists (1980-1991)
Metals Economics Group (1991-Present)
U.S. Department of Energy, Energy Information Administration (1974-1999)

Another indicator of exploration activity is a measure of the amount spent on exploration. Unlike drilling data, this measure covers the costs at all stages of exploration, from initial reconnaissance mapping, sampling, or geophysics to late-stage exploration associated with deposit development. Data of this type are currently readily available for the oil and gas sector, but actual exploration expenditure data for the nonfuel minerals sector are only available for the period 1980-91, and industry coverage of these data was quite low and variable. Data on nonfuel mineral exploration budgets are currently available, however, and industry coverage rates are much higher.

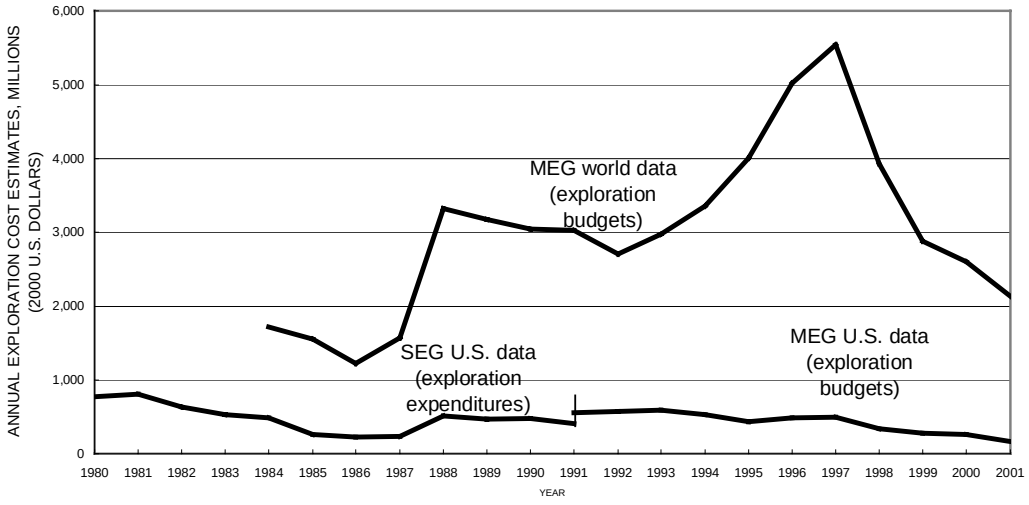
The Society of Economic Geologists (SEG) compiled actual expenditure data for nonfuel mineral exploration for the period 1980-91. Data were based on voluntary industry surveys, and coverage estimates range from about 85 percent during the early years to about 40 percent in the later years of data compilation. Although current data of this type could be compiled from individual company annual reports or Security and Exchange Commission 10K reports, such an effort would be time consuming and data quality and subjectivity would likely vary based on company reporting policies. In addition, actual site expenditure data often are not broken out or are not reported until well after the expenditure date, so consistent data are not always available or current. Metals Economics Group (MEG) of Halifax, Nova Scotia, Canada has compiled data on mineral exploration budgets since 1991, however. Such data show the relative interest exploration companies have in exploring various regions of the world. These data show where exploration efforts are planned, but are not directly indicative of the success of such efforts. Where data are available, however, there appears to be a good correlation between MEG budgeted data and reported actual expenditure data. Exploration budgets are subject to available financing by the investment community, and shift according to changing corporate goals and priorities.

Actual expenditure data for oil and gas exploration were compiled for the period 1977-2000 by the U.S. Department of Energy based upon responses to industry survey canvass forms. Data include reported exploration expenditures for those major U.S. energy companies that form the Financial Reporting System (FRS) of the Energy Information Administration (EIA). Data for exploration expenditures include costs associated with acquiring unproven lease acreage, drilling exploratory wells, geologic and geophysical work, and other associated costs, including direct overhead. Costs for proven resource acquisition and development drilling were excluded, in order to keep data for this sector comparable to data for the nonfuel minerals sector.

The reliability of both nonfuel mineral and oil and gas exploration data as an indicator is tied to industry survey coverage. Raw nonfuel mineral expenditure data, collected by SEG for the 1980-91 period, reflect expenditures of U.S. companies exploring in the United States. Estimates for total U.S. exploration investment by U.S. companies were made by first determining what percentage of the total U.S. investment the reported annual expenditure represented, then adjusting this estimate to reflect the total estimated U.S. expenditure. Similarly, exploration budget data for the period 1991-2001 were adjusted based on estimates of annual survey coverage to reflect total coverage. Reported coverage rates for the raw MEG data ranged from 69 to 92 percent, with higher coverage rates reported for the later years. While coverage statistics for oil and gas data are not reported, the U.S. Department of Energy is required by law to report energy statistics annually to Congress based on a "uniform and standardized basis" to provide a "statistically accurate profile" of the industry. Companies included as part of the FRS are required to submit data annually to the EIA. The composition of the FRS may change with industry or corporate restructuring, however. These data should consistently represent a uniform percentage of the industry. No attempt was made to adjust these data to reflect the total estimate for U.S. exploration.

Nonfuel minerals:

Figure 5a. - U.S. and world nonfuel mineral exploration costs, 1980-2001.



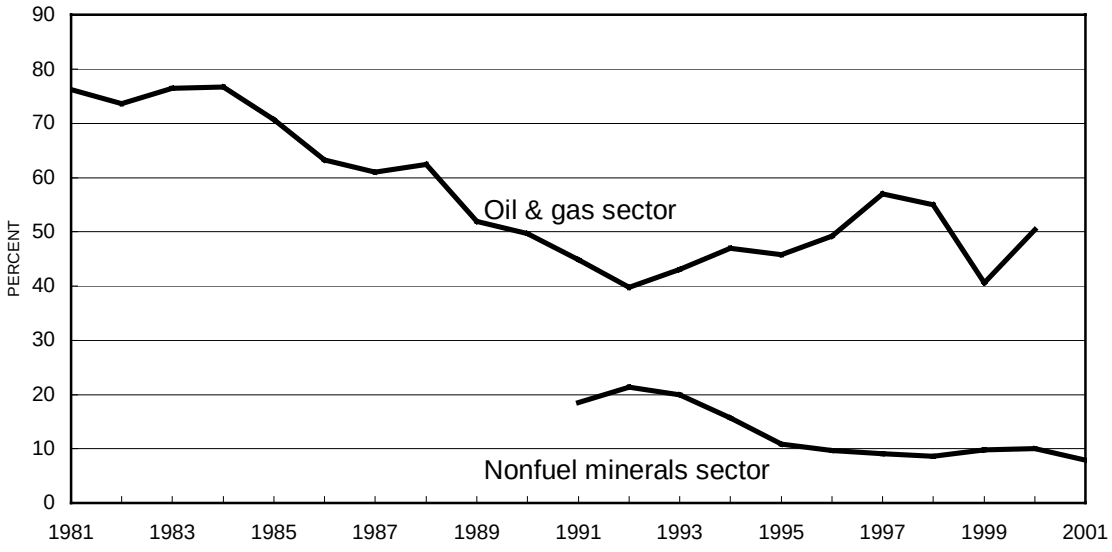
Sources: Society of Economic Geologists, 1980-1991; Metals Economics Group, (world 1984-2001; U.S. 1991-2001)

Figure 5a illustrates the U.S. nonfuel mineral exploration dollars either budgeted or expended for the last 22 years. Note that the U.S. data have been reported as two separate components. Data from 1980-91 reflect estimates of U.S. actual exploration expenditures based on the data collected annually by the SEG. Data for the period 1991-2001 reflect estimates of the total U.S. exploration budget for specified years,

based on data collected by the MEG. The vertical line separating these data indicates that they should be treated as separate data series. Each data set reflects the best data publicly available for the corresponding timeframe. Both data sets are related by common data collection methodology. In addition, the same personnel were used in the compilation of both sets of data for 1991-92. The U.S. Geological Survey has been reviewing and interpreting these data since 1983, and publishing their annual findings (Mining Engineering, May issue, 1984-2002). Both sets of data focus on nonfuel mineral commodities, primarily precious and base metals. Data for energy minerals have not been included, and the quantity of available mineral exploration data on industrial minerals is small in comparison. In general, data do not include exploration at active mining sites, but exceptions may exist based upon how the data were reported. Data have been converted into constant U.S. dollars with a base year of 2000, using the Consumer Price Index (CPI). The CPI is published by the Bureau of Labor Statistics, U.S. Department of Labor, and is available on the internet at http://data.bls.gov/cgi-bin/surveymost.

Figure 5a also reports the estimated worldwide nonfuel mineral exploration budget on an annual basis, after adjustment using industry coverage estimates. Reporting U.S. exploration activity by itself can be misleading if it is not linked to world exploration activity. The mining industry is increasingly becoming more global, as U.S. and foreign exploration companies merge and consolidate and the exploration environment becomes more favorable overseas. World exploration budgets compiled by MEG are shown in figure 5a to provide distinctions between U.S. and worldwide exploration trends. Data are also provided in figure 5b to show the U.S. share of world nonfuel minerals sector exploration activities, as illustrated by exploration budgets, and U.S. share of oil and gas exploration expenditures spent in

Figure 5b. - Summary of the U.S. share of world exploration expenditures for selected natural resource sectors.

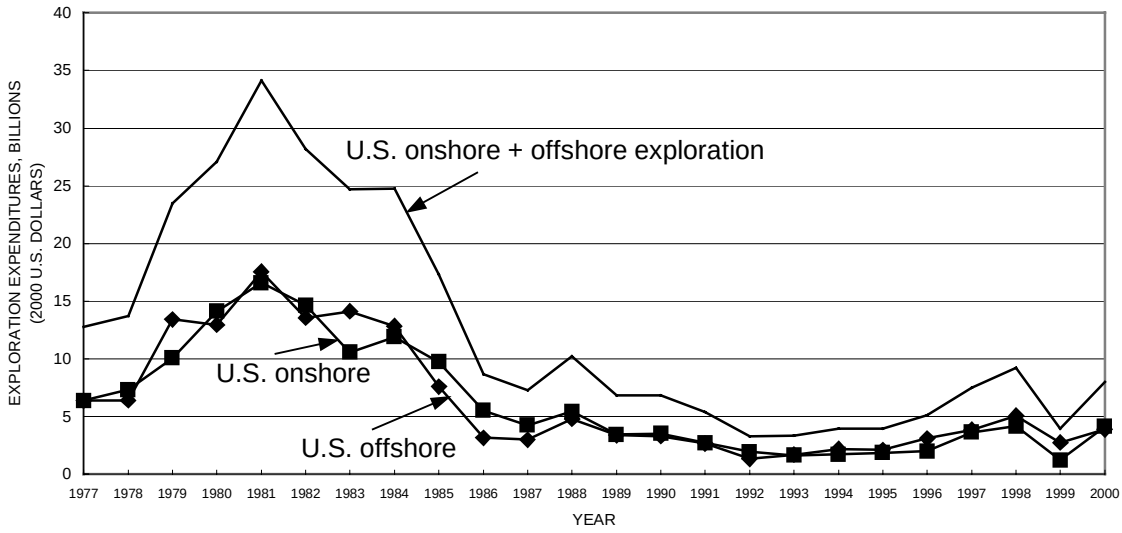


the United States by major energy-producing companies. The figure shows a downward trend of nonfuel minerals exploration in the United States as compared to the rest of the world over the last decade, while the oil and gas sector shows a slight upward trend for the same period. The minerals sector has incurred higher U.S. mining and exploration costs associated with deeper deposits and increasing environmental regulation requirements; the emergence of attractive overseas exploration targets owing to the opening of the former Soviet Union and China to foreign exploration, increased privatization, and liberalization of foreign tax and investment policies; and contraction of the U.S. mining industry. Since 1993, Latin America has been the region with the greatest exploration budget. By 2001, budgeted exploration spending in Latin America, Australia, Canada, and Africa have each exceeded budgeted exploration spending in the United States. The higher share percentage for oil and gas exploration reflects the strategic nature of these resources to the United States.

Oil and gas:

Figure 5c illustrates the U.S. oil and gas exploration expenditures for the period 1977-2000. Data show expenditures for both onshore and offshore oil and natural gas exploration in the United States. Data show similar trends for both onshore and

Figure 5c. - Annual oil and gas exploration expenditures, 1977-2000.



U.S. Department of Energy, Energy Information Adminstration

offshore exploration. Since 1986, exploration for onshore and offshore oil and

natural gas exploration have each ranged between $2 to $5 billion dollars annually, in constant 2000 U.S. dollars. Figures were extracted from the EIA-28 survey form, and include data from only those major U.S. producing energy-producing companies included in the FRS. Because coverage percentages are not reported, no attempt was made to adjust these data to reflect total U.S. coverage. As with the nonfuel minerals data, expenditures have been converted into constant 2000 U.S. dollars using the CPI.

Because the data chosen to represent the U.S. oil and gas industry exploration level was based on a representative sample of U.S. companies only, it is not surprising that the bulk of their activity would be centered in the United States. The data shows that approximately 40 to 76 percent of the total exploration expenditure incurred in the United States over the entire time period where data were available. Generally, the percentage of U.S. company expenditures decreased during 1984-92, while the percentage share spent in the United States in the last decade has increased slightly from 40 percent to about 50 percent in 2000. Data for foreign companies conducting energy exploration in the United States are not reported.

INDICATOR 2.3 DISCOVERY RATE/$ OF EXPLORATION
DATA COVERAGE: Oil and gas
DATA UNITS: Barrels crude oil equivalent (COE) per dollar (2000 U.S. dollar)
DATA SOURCE: U.S. Department of Energy, Energy Information Administration

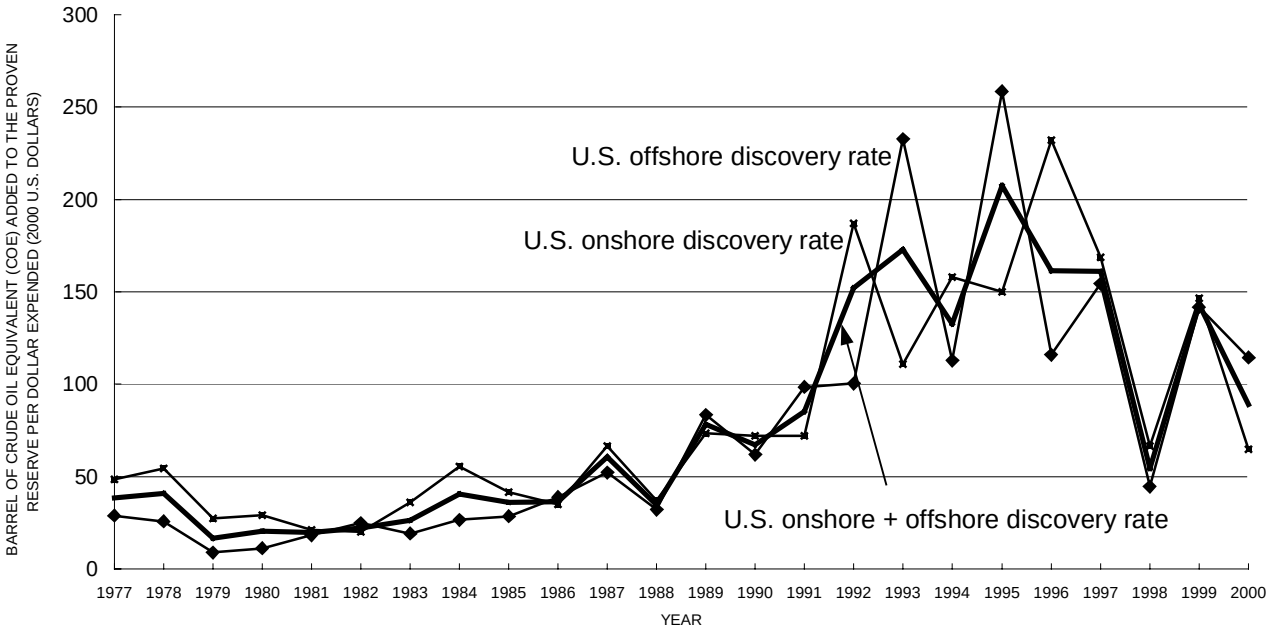
Data of this type would make the best exploration indicator, but reliable, consistent sources of data are difficult to acquire for the nonfuel minerals sector. Development of this data series is recommended, if possible. Quantification of what constitutes a "discovery" and its value determination would need to be made. Perhaps a measure of the quantity of reserve (resource) discovered per dollar value expended would be the most useful. A measure of extractable dollar value per dollar value expended may also be possible, but that could only be determined after properties have reached the feasibility level. Because the majority of exploration prospects do not reach the feasibility stage, such a measure would not be as good an indicator as a discovery rate indicator based on the tonnage of reserve added per dollar expended.

The U.S. Department of Energy (DOE) annually publishes the amount added to the proven U.S. oil and gas reserve (defined as those quantities that geologic and engineering data demonstrate with reasonable certainty to be recoverable in the future from known reservoirs under existing economic and operating conditions) and the amount spent on oil and gas exploration and development expenditures for each year since 1976. The DOE uses these values as an indicator of oil and gas discovery rate, but some qualifications for use of these data as an indicator of exploration discovery rate are necessary. These data include both exploration and development expenditures. Annual reserve change data as reported include reserves purchased by reporting companies and added to company reserves in the specified year; such values may overshadow reserve additions credited from new field discoveries and extensions (assumed to be exploration based) for some years. To be comparable with nonfuel minerals data, only exploration expenditures would need to be reported. This component of the data has been reported in separate tabulations from data collected as part of the Energy Information Administration's Financial Reporting System (FRS). As stated previously, coverage of these data are assumed to be high, but no actual coverage information is reported. A discovery rate indicator was developed from the FRS data by estimating the amount of crude oil, natural gas liquids, and natural gas from extensions and discoveries that was added annually to the domestic oil and gas reserve, then comparing these values to the amount expended for the comparable year. The resulting ratios, shown in Figure 6, approximate the quantity of proven petroleum reserves attributable to exploration for both onshore and offshore discoveries.

Data of this type published for oil and gas exploration are price sensitive. Consequently, care should be taken when using such data over time without taking prices into account. For example, the increase in crude oil prices between December 1998 and December 1999 boosted crude oil reserves during this period, in spite of a drop in exploratory oil well drilling for the same period of about 40 percent. Data have been converted into constant 2000 U.S. dollars using the CPI to reflect constant

dollars with a base year of 2000. Figure 6 shows this indicator for the years 1977-2000. As already stated, similar data for the nonfuel minerals sector are not available.

Figure 6. - Discovery rate for oil and gas, expressed in terms of additions to proven reserve per exploration expenditure.



Source: Energy Information Administration

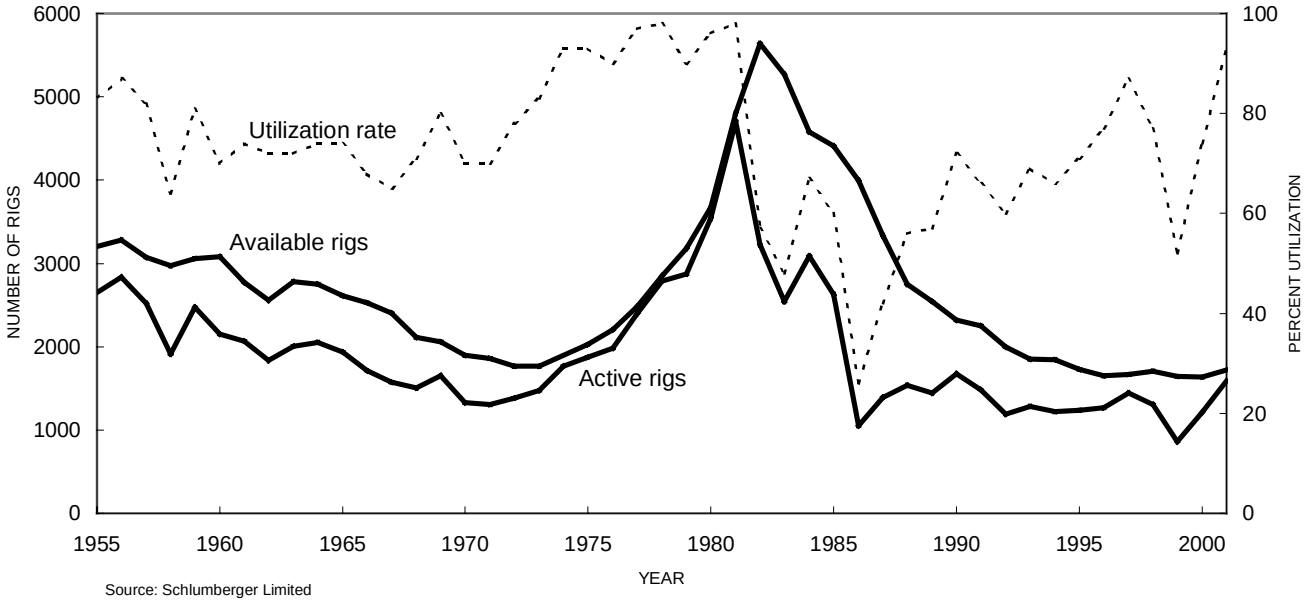
Based upon this indicator, the discovery rate for oil and gas gradually increased until it reached a peak of just over 200 barrels per dollar expended in 1995. For the period 1977-88, onshore exploration discovery rates tended to exceed offshore rates. This corresponds to the timeframe when the North Slope of Alaska was actively being explored. Since 1988, however, offshore rates are higher in some years while onshore rates are higher in others. The overall increase for the period 1978 to 1995 can be attributed, at least in part, to improved exploration technology. Implementation of directional drilling, improvements in deep drilling and off-shore drilling at depth, and pipeline technology improvements developed during the 1980s have allowed for expanded drilling capability while maintaining drilling costs at reasonable levels. Since 1995, however, the amount added to the proven domestic oil and gas reserve has decreased to a level of about 80 barrels for each dollar expended for exploration.

INDICATOR 2.4 EXPLORATION RIG UTILIZATION

DATA COVERAGE: Oil and gas only
DATA UNITS: Number of active and available rigs
DATA SOURCE: U.S. Department of Energy, Energy Information Administration

Another indicator of the health of the domestic oil and gas industry is the active exploration drilling rig count and corresponding rig utilization rate, which is the ratio of active to available exploration drilling rigs. Figure 7 illustrates both the number of active or available rigs for the period 1955 to the present, and also shows the annual utilization rate of the drilling rigs. Periods of highest active rig count generally correspond to periods of increasing energy prices. Not surprisingly, the data represented by the active rig plot of this indicator are similar to the data represented by the drilling indicator for the oil and gas sector (figure 4, main text).

Figure 7. - Available vs. active oil and gas rigs exploring in the United States.



A high utilization rate may not always be a positive indicator of short-term industry health. For example, utilization rates above 90 percent occurred for the period 1974-81, when the oil and gas industry was booming. A utilization rate above 90 percent also occurred in 2001, but in this case the domestic oil and gas industry, based upon the reported active rig level, was not growing. For this year, the number of new rigs that became available approximately equaled the number of rigs that were being decommissioned. This indicator does not include rigs requiring significant capital expenditure for maintenance or repair; therefore, it does not provide sufficient information on the health of the industry fleet. For example, the 2001 data excluded 96 rigs that required major repairs or those cannibalized to keep other rigs working.

While only 7 percent of the available rigs in 2001 were idle, approximately 14 percent of the available units are scheduled for refurbishment or upgrades in the near future. Even though the annual utilization rate was above 90 percent in 2001, the number of total rigs in service was about 2000, well below the 5900 rigs available in the peak years of exploration.

Data on domestic oil and gas rig counts are available from several sources, but Schlumberger Limited reports the most comprehensive data, which are available for the period 1955-2001. Corresponding data from the Department of Energy are available for a shorter time period. Comparable data for nonfuel minerals are not available.

INDICATOR 2.5 DOMESTIC COAL LEASES AND LICENSES

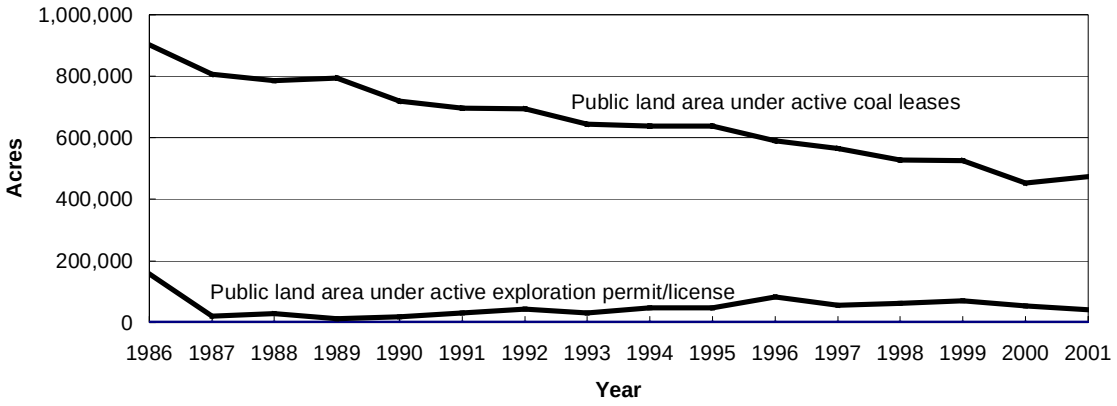
DATA COVERAGE: Coal on public land
DATA UNITS: Acres held under active leases and permitted under active exploration licenses
DATA SOURCES: U.S. Department of the Interior, Bureau of Land Management
U.S. Department of Energy, Energy Information Administration
U.S. Department of the Interior, U.S. Geological Survey

Because existing coalfields are extensive and well documented, no new coalfields have been developed in the United States within the past 25 years (T.J. Rohrbacher, U.S. Geological Survey, oral commun., 2002). The Energy Information Administration (U.S. Department of Energy, Energy Information Administration, 2001) has estimated a demonstrated coal reserve base as of January 2000 of 502 billion short tons (455 billion metric tons). Consequently, domestic exploration for coal is not widespread and has focused on expanding existing reserves of the coalfields rather than defining new areas.

A principal force that is shaping domestic coal mining is the need to comply with the 1990 Clean Air Act Amendments, which set Federal regulations on sulfur dioxide (SO_2) emissions from powerplants. SO_2 emissions from coal-fired powerplants are highly influenced by the sulfur content of the coal burned as fuel. About 35 percent of the coal shipped from the central Appalachian Basin coal region (Kentucky, Tennessee, Virginia, and West Virginia) , 75 percent of the coal shipped from the Colorado Plateau (Arizona, Colorado, New Mexico, Utah), and 90 percent of the coal shipped from the Powder River Basin (Montana, Wyoming) currently complies with the 2000 Phase II SO_2 emissions compliance standard. As a result, powerplant owners representing about 55 percent of productive electrical capacity are planning to switch to low-sulfur coal, plants representing 35 percent of electrical capacity are planning continue to use high-sulfur coal and meet compliance by purchasing SO_2 allowances, and plants representing 10 percent of electrical capacity are planning to switch to another fuel, shut down boilers, or install flue-gas-desulfurization systems (U.S. Department of the Interior, U.S. Geological Survey, 2001, Fact Sheet 158-00).

New exploration is centered in the western states, primarily Colorado and Wyoming, where low sulfur coalfields are predominant. For the most part, the coal from these areas meet phase II SO_2 emissions compliance standards when burned. Coal exploration expenditures and drilling data are not available, however data on active coal exploration lease and license areas on public lands have been published (figure 8) and may reflect trends in coal exploration activity. Such data only show the public lands component of coal exploration in the United States, so coal lease information is not an ideal indicator for exploration. The area being leased for coal exploration appears to be decreasing, reflecting a downward trend of coal exploration. These data do not include an expanding search for coal bed methane, which is included under oil and gas.

Figure 8 - Coal leasing and licensing data, 1986 - 2001



Source: U.S. Department of the Interior, Bureau of Land Management

Note to reviewers:

The attached indicator(s) to be reviewed are part of the USGS's contribution to the report "Indicators of energy and mineral resource contributions to sustainability". This report will be the product of the Sustainable Minerals Roundtable, a multi-stakeholder (Federal, State and local governmental agencies, non-governmental organizations, Tribes, and private industry) effort to develop indicators of sustainable development for mineral/material and energy systems.

The USGS is responsible for developing multiple sets of indicators in areas related to its expertise, the attached indicator is one such example. Other stakeholders are simultaneously developing different indicator sets for which they have expertise.

It has been decided to review these indicators within the USGS review process as they are completed. The format and numbering system followed by these indicators matches that as developed by the Sustainable Minerals Roundtable. The initial section is a summary of all indicators in the set of indicators, followed by an appendix listing the details of each individual indicator.