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THE NATIONAL NEED FOR OIL AND GAS RESEARCH

INTERSTATE OIL COMPACT COMMISSION RESEARCH COMMITTEE

REPORT OF THE SUBCOMMITTEE FOR OIL AND GAS RESEARCH SUPPORT

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INTRODUCTION

Oil production in the United States has dropped precipitously since 1985, from 8.9 million barrels per day to 8.3 million barrels per day. At the same time, demand has surged from 14.6 million barrels per day to 17 million barrels per day. The resulting supply gap is imported oil. Currently, total imports (including products) supply over 41 percent of the U. S. daily demand for petroleum liquids, up from a 1985 low of about 26.5 percent. Demand continues to increase, while crude production continues to slide (fig. 1)

Similar statements could be made about natural gas production. In 1985, industry replaced only 74 percent of domestic production (1). Although this report emphasizes research for oil production, most points made are equally applicable to natural gas development and production.

BACKGROUND

Many reports have been written about this phenomenon; all concur that the energy security of the United States is at risk and our balance of payments deficit is exacerbated by growing dependence upon imported oil. At the same time, few reports have suggested any solution to the problem. Recently, Fisher (2) outlined a technical scenario by which the United States could support a sustained oil production base; other reports argue for economic incentives to sustain production.

Price decreases based on over-supply by Persian Gulf producers have devastated the United States exploration and development industry. Even as prices declined, overproduction by OPEC producers to increase market share (and thus maintain cash flow) has continued to wreak havoc with prices. Prices continue to be unstable and too low to sustain reasonable levels of petroleum development in the United States.

Exploration and development drilling in the United States portend future supplies; a positive correlation between drilling effort and future production can be seen in the drilling boom of the late 1970's and the resultant increase in national production of the early 1980's. Consequently, the low drilling levels of the late 1980's (fig. 2) and the plugging of newly uneconomic wells owing to price decreases and cost increases during the same period lead to sustained declines in domestic production; the loss of many stripper wells has permanently removed significant production.

Role of Independent Operators

Further, the domestic industry, unlike the overseas industry, is dominated by independent operators. Of 26,695 completions in 1987, only 5,885 were by the top twenty producing companies, and of those, only ten could be considered integrated (3). Further, there were 5,725 operators total in 1987, down nearly 27 percent from 1986 and down 47.5 percent from 1985 (3). It is axiomatic that these independent operators do not have research divisions nor can they access much of the research performed by the integrated petroleum

companies. Yet, independents and smaller companies produced over four million barrels of oil per day (42 percent of the domestic total) in the United States in 1987 (4) and operate numerous fields which could contain large additional reserves if properly exploited using the latest technology and concepts.

Need for Additional Domestic Supplies

Demand for oil in the United States continues to climb. By June of 1985 demand had dropped to a little more than 14.5 million barrels of oil per day, but demand has risen since then in response to an expanding economy and lower product prices. Current demand (September, 1988) is a little over 17 million barrels per day. Crude production was 8.85 million barrels per day in June of 1985, but now is less than 8.2 million barrels per day (5). Calculation from these numbers demonstrates that we have increased imports by 3.1 million barrels per day.

Consumer demand is partly driven by price considerations. However, in the event of an externally-driven price jump, demand may drop, but production cannot be immediately driven upwards. First, some former reserves now are irretrievable, since small yield wells, once plugged, are extremely unlikely to be re-opened. Second, despite heroic efforts by the industry, the process of developing a drilling project from concept to production requires years. Well-planned programs of exploration and development frequently require six to eight years before actual positive cash and product flow results; environmental or regulatory delays lengthen that period.

Capital requirements to maintain a solid national exploration and development industry are immense. In 1987 about $8.8 billion was spent to drill and complete oil and gas wells, an eleven year low (3)! Even this level of spending requires a constant search for risk capital, made much more difficult by both lower prices and price instability, and especially, tax considerations. Changes in the tax brackets over the last eight years have reduced tax percentages and thus decreased the value of tax deductions; a consequence of this otherwise desirable situation is the drying up of traditional sources of high risk capital investments.

New environmental and workplace regulation has impacted the ability of the United States to produce oil. Land access, drilling process controls, production restrictions and production wastes disposal costs all increase or otherwise inhibit development of new production. It is popular in America to embrace the "NIMBY" syndrome, that is, "Not In My Back Yard!" despite desperate national needs (witness arguments and lawsuits over low level radioactive waste disposal, offshore drilling, nuclear power, hazardous waste disposal, low income housing and the like).

In consequence, the nation has arrived to a position of declining control over its entire energy supply and critical loss of control over its oil supply. It is necessary now to address the problem of oil supply for the future.

Source of Present Supply

Most existing oil fields have previously been found in structural traps in sandstone reservoirs, although numerous combination traps also produce (fig. 3)(6, 7). These are the easiest targets to locate and the largest of these are the easiest of the group to locate; declining size creates higher risk. Also, carbonate reservoirs are generally more difficult to locate than sandstone reservoirs. Exploration for complicated stratigraphic traps is probably a generation away.

Several conclusions emanate from that information. First, in simplest possible terms, the easy oil has been found. Second, increasing numbers of smaller and more difficult to locate traps must be discovered, either by deeper or more focused drilling. Third, more oil must be extracted from known accumulations. Additional complicated traps may be discovered that contain large quantities of oil, but discovery of large oil fields requires ever-increasing amounts of drilling (fig. 4). Finally, the technology to efficiently explore for stratigraphic and other subtle traps must still be developed through research and new concepts.

Although the industry does a good job in application of research to finding and producing new oil, many challenges toward development of predictive exploration and production models exist, using the vast array of computer tools now available. To date, the technological changes necessary to increase our domestic oil supply have not been instituted.

FUTURE DOMESTIC SUPPLY

Economic Considerations

There is widespread misconception among the general public that the oil exploration and development business is inordinately profitable. It is not. Simply stated, oil well drilling provides scientific success more frequently than it provides economic success. Many small accumulations are encountered that can not be produced at a profit or even at cost. Consequently, the search for future domestic supplies requires policy considerations about price stability, tax levels and capital availability. Present consumption rates can only be sustained by discovery of at least one significant new field per day or the equivalent in additional recoveries from existing fields.

Future supplies of oil for the United States must be based upon a scenario that includes state, local and federal recognition that economic success of oil operators is the only basis upon which a domestic supply can be maintained. Like all other industries, operators expect to make a profit from their labors and the extreme risks they take. As previously noted, the need to drill extensive numbers of wells to discover significant fields (those ultimately producing one day's supply for the United States) specifies that a large number of unsuccessful wells must be drilled also.

Tax levels are particularly high at state and local levels, with many counties relying upon oil property tax revenues for much of their income (fig. 5); this provides a method of not taxing traditional tax base properties and activities. Although the federal government has finally repealed the "Windfall Profit Tax," the very imposition of this excise tax in the first place illustrates the severity of the perceptual problem of oil industry profitability.

If technological research is to materially affect the domestic supply, then economic research and actions must assist by maintaining a stable and coherent policy of economic encouragement of oil development.

Potential Giant Oil Fields

One possible source for additional domestic oil supplies would be the discovery of giant oil fields (greater than 100 million barrels). Although new technology can help find such targets, maturity of exploration in many areas nearly precludes the possibility of finding additional giant fields. This does not imply that none will be found, only that the numbers

of these very large fields necessary to stabilize national production levels are extremely unlikely to be discovered in traditional areas of exploration.

Areas in which giant oil fields may be most likely to occur are in frontier areas, those areas which are technologically difficult to explore. In nearly all cases, the potentially good exploration areas are contested by those who wish to preserve the areas from any intrusion (except for recreation) or in response to the NIMBY syndrome. Cases in point are northeastern United States offshore, California offshore, North Slope of Alaska, and the Rocky Mountain overthrust belt. In each case a major battle rages between those who would define the potential resource base and those who would preclude gaining that knowledge.

There is one large area still open, for the most part, that has giant field potential, the "Great Basin" of western Utah and Nevada. This region is one of the most geologically complicated exploration areas of the world, and new techniques must be developed to effectively search for its resources. The highest producing rate oil well in the United States is located in that province.

One of the greatest problems facing development of frontier areas and potential giant fields in the United States is simply the greater success in finding similar reserves at a lower unit cost in foreign countries. Competition for drilling capital from foreign locations has greatly reduced the possibilities for extensive drilling domestic locations, particularly since the capital investment is welcomed in foreign locations and discouraged in most domestic areas.

Non-Giant Domestic Potential

Discovery of new fields is generally assumed to be a logarithmic success effort, that is, that discoveries become less frequent and become smaller with increasing effort as a geometric progression. Fisher (2) has argued that this is not really the case; his data indicate that there are sustained levels of discovery that can materially affect the oil supply of the United States if a high level of drilling can be attained. Present production rates could be sustained for 20-40 years if the scenario posed by Fisher could be attained.

His concept has great bearing upon the need for research. If operators can be convinced to drill more wells, then applied research leading to more effective selection of targets, better evaluation of encountered pools and greater recovery from new pools can increase both actual production levels and lengthen the time over which fields produce. Increased production efficiency can result from research.

Reserve growth through new pool discoveries and deeper drilling within known shallow fields is one other possibility for maintaining existing production levels. Creation of new concepts that permit location of new and deeper pools, including within known accumulations is one aspect of current research. Extension of that technology, such as better seismic definition of reservoir heterogeneity, is one area of major research need.

How Much Oil is There to be Found?

In 1980 the federal geological survey (8) estimated that there were about 83 billion barrels of oil yet to be found in the United States; current estimates are considerably lower, although they may not yet be cited. At the same time, several estimates of unrecovered oil associated with known accumulations average some 320 billion barrels. Of this, 100 billion barrels or more are in unswept mobile oil, that is, oil that has not been encountered

through current drilling and completion practice. An estimated 220 billion barrels are immobile, but are a target resource if ways to mobilize the oil can be developed.

These potential sources of oil are to be found in undrilled small pools associated with known large fields, in small isolated portions of heterogeneous reservoirs, in low reservoir energy zones, and in undrilled play extensions and pool extensions. Regardless of the accuracy of the estimates, there is general consensus that immense recoverable oil volumes exist in these settings, but that much research is necessary to extract these resources.

CURRENT EFFORTS

Efforts to locate and extract the potential resources are seen in the local independent industry, major industry, state and federal programs, although none are sufficient to effectively stem the production declines we see. Many reserve additions are accomplished by improved recoveries from existing accumulations rather than new discoveries.

A specific example of a successful state effort has been the redevelopment of the Glenburn Field of North Dakota (9). This intermediate depth (4,000 feet) Mississippian pool was discovered in 1958 and produced over 100,000 barrels per month in its early history. By 1979 production had decreased to 30,000 barrels per month. Research into the nature of the reservoir and origin of the porosity by the North Dakota Geological Survey indicated infill drilling and changed completion and evaluation practices to be desirable. Since that time, production jumped to 70,000 barrels per month and at least 2,200,000 barrels recoverable reserves were added to the field. The estimated cost of the research is about $20,000.

Similar success stories are found where concentrated efforts to enhance existing production have occurred. Studies by the Bureau of Economic Geology in Texas have substantiated infill drilling programs based on new reservoir models that have added tens of millions of barrels of oil to reserves and production (10).

Major oil companies have expended large sums of money in research, but that research is targeted towards high-potential--high-risk frontier areas and most of the research is, and will remain, proprietary (11). Transfer of specific licensable technology takes place, but slowly. Although some significant advances may result from major company research, it will not be generally available to the nation and does not focus on the vast amount of unrecovered mobile oil thought to be present in existing fields.

Independents and small companies do not now undertake research per se, since they have no staff nor resources to expend in large-scale efforts nor could they exploit internally generated research concepts because of capital shortages. It is unlikely that these operators will undertake extensive research programs in the future for the same reasons.

Most effective research programs focused on extracting more oil from existing reservoirs seem to be located within the states, particularly at the several state geological surveys and to a lesser degree, at universities. Although funding for these programs has been minimal, they have been effective and they have created working groups of experts who could address national issues in technology development. They tend to be focused on applications of their research to the solution of recovery problems.

Federal efforts have been minimal in oil and gas recovery research. FY 1987 DOE budget in Geosciences was approximately $15 million, in FY 1988 it was $16.5 million, and the FY 1989 request was for $17.9 million; by comparison, the FY1988 appropriation for fossil energy (coal) was $327 million, with a committee recommendation of $371 million

for FY 1989. Considering the importance attached to maintaining a national oil production capacity suggested by several major reports (12, 13, 14, 15), it appears that DOE has not responded to the declared needs nor have they been responsive to efforts of the states to develop funding for additional recovery research.

Department of Energy efforts have not all been futile. Research is being conducted through the national laboratories and a cooperative agreement with the several states has been instituted to fund some low levels of mutually acceptable research, but overall, the DOE has given only token support.

Major efforts have been initiated by several states. The most significant of the cooperative efforts has been the development of the Geoscience Institute for Oil and Gas Recovery Research, initiated by about ten states originally, and now expanded to include most of the oil-producing states and some academic institutions. This consortium has been successful in generating a priority-based program of national scale research in additional recovery, including enhanced or tertiary recovery. Through the efforts of this group, $5 million dollars has been included in the DOE budget for matching to state-developed funds for consortium support. It is unclear as to whether the amount will be finally approved and how the money will be fed into the research programs. The initial request was for $20 million, which is the level of research that could be supported by matching money from the states at this time. Other regional or local groups also hope to see funding developed within the federal government to the support of oil research, although some of these are oriented towards better exploration technology rather than the additional recovery focus of the Geoscience Institute.

Parenthetically, the National Governors Association is preparing a statement on policy options towards solving the domestic production issue; they also call for additional research in the circulating draft.

Problems and Opportunities

It seems that the issue of need for additional and sustained oil production in the United States has been generally understood by many federal organizations, but that the intellectual understanding has not been translated into budget or policy initiatives. Although oil recovery research is but one approach needed to address the supply problem, it is one that has been identified, it has been provided with a plan for work, it has been demonstrated to make the most significant impact for the least investment, it can have a quick turn-around, and it has county-wide application.

Now that the issue has been presented, with solutions, it is appropriate for Congress and the various federal agencies to proceed to implement the program and its plans. The opportunity to address a national issue with the help and cooperation of the various states and private industry is one we cannot ignore.

SUMMARY

Two areas of federal action must be addressed. One is to provide economic incentives or eliminate disincentives to oil discovery and production. Specifically, reduction of punitive tax treatment of the petroleum industry which has helped crush the industry, especially the independent, must be instituted. Production taxes set at fair levels in lieu of all other pre-profit property or ad valorem taxes would be an acceptable approach. Risk capital markets must be re-opened by instituting tax advantages to the risk-takers, so that the market place works to the same end as the national need.

Second, technology development for additional recovery efficiency and for more effective exploration is desirable. Federally funding to the established research community can greatly decrease the idea-to-market time period for applications research. Spin-off of fundamental concepts applicable to exploration, development and recovery research form all programs could stabilize the domestic production level for an extended period of time.

Smaller targets will require much additional drilling; additional drilling can be made more efficient; successful drilling can be enhanced by better recovery ratios.

A policy of national support for oil location and recovery research with budget commitment would be a proper response.

IOCC RECOMMENDATIONS:

1. The IOCC recommends adequate funding for oil research, specifically including funding at the $20 million level for consortia such as the Geoscience Institute. A better balance between coal funding and petroleum funding, including advanced exploration technology, is also recommended.

2. The IOCC recommends that the federal government, as part of an energy policy, create incentives to develop our oil resources by increasing the technology through research, availability of capital through favorable taxation, and access to public lands through common sense rules and regulations.

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Figures captions:

1. Graph of United States demand vs. domestic production, showing increasing demand and decreasing production. Growth of consumption has been over 2 percent annually, whereas production continues to slide as new wells are not drilled to replace depleted wells. Small, stripper, producers have become uneconomic at an accelerated rate.

2. Graph of rigs working vs. year, showing the effects of the economic downturn on drilling activity. Since these numbers include developmental drilling as well as exploration, it becomes clear that new production has been severely constricted by low drilling levels in recent years.

3. Graph showing trap style and reservoir lithologies for significant U.S. oil fields, data from Nehring, adapted from Gerhard, et al., Oil and Gas Journal (6). Future drilling success will require exploitation of combination traps and carbonate reservoirs which are presently under-represented in these statistics. Likelihood of continued success in exploitation of clastic reservoirs and structural traps is reduced as more are discovered and produced.

4. Number of exploratory wells necessary to find significant and large fields (6). Increased drilling necessary to find significant fields has required tremendous new risk capital outlays when risk capital has been decreased by tax law changes.

5. Kansas rural mill levies by county by year. Mill levies are used to calculate ad valorem taxes on oil and gas operations. These data show a strong shift to increased tax load on the oil industry, largely as lower oil prices and lessened drilling activity have strained total county revenues. (a) 1973 data (b) 1987 data.

FIG 1 DEMAND, PRODUCTION AND IMPORTS

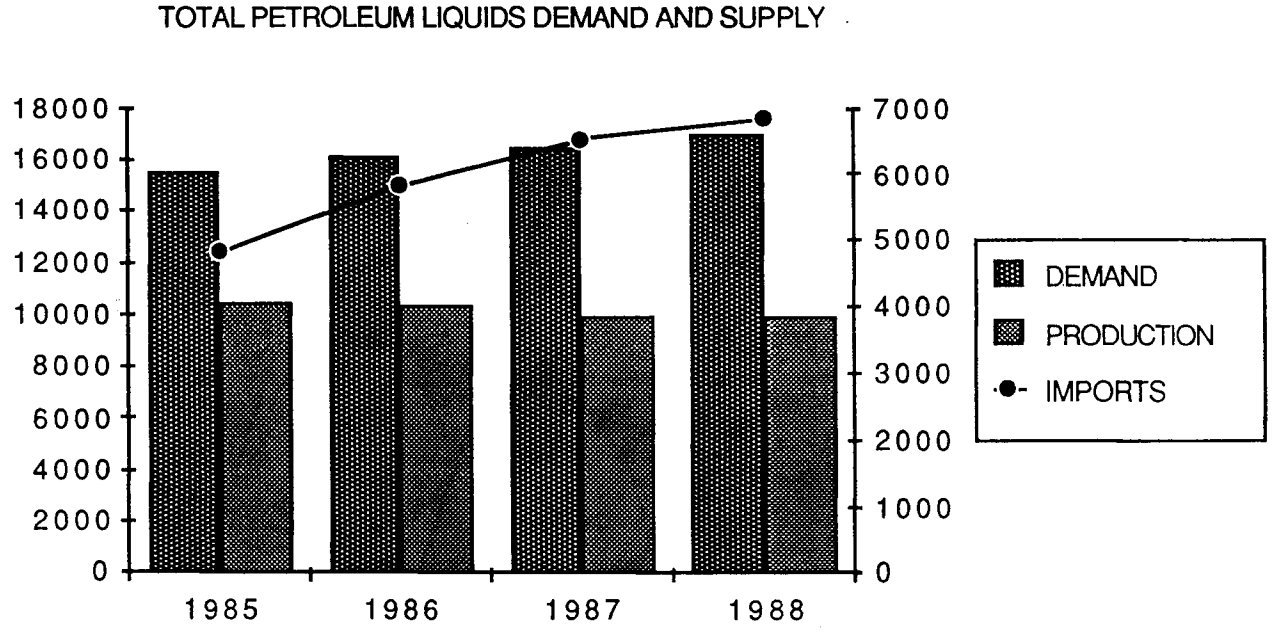


FIG. 2 RIG COUNT BY YEAR

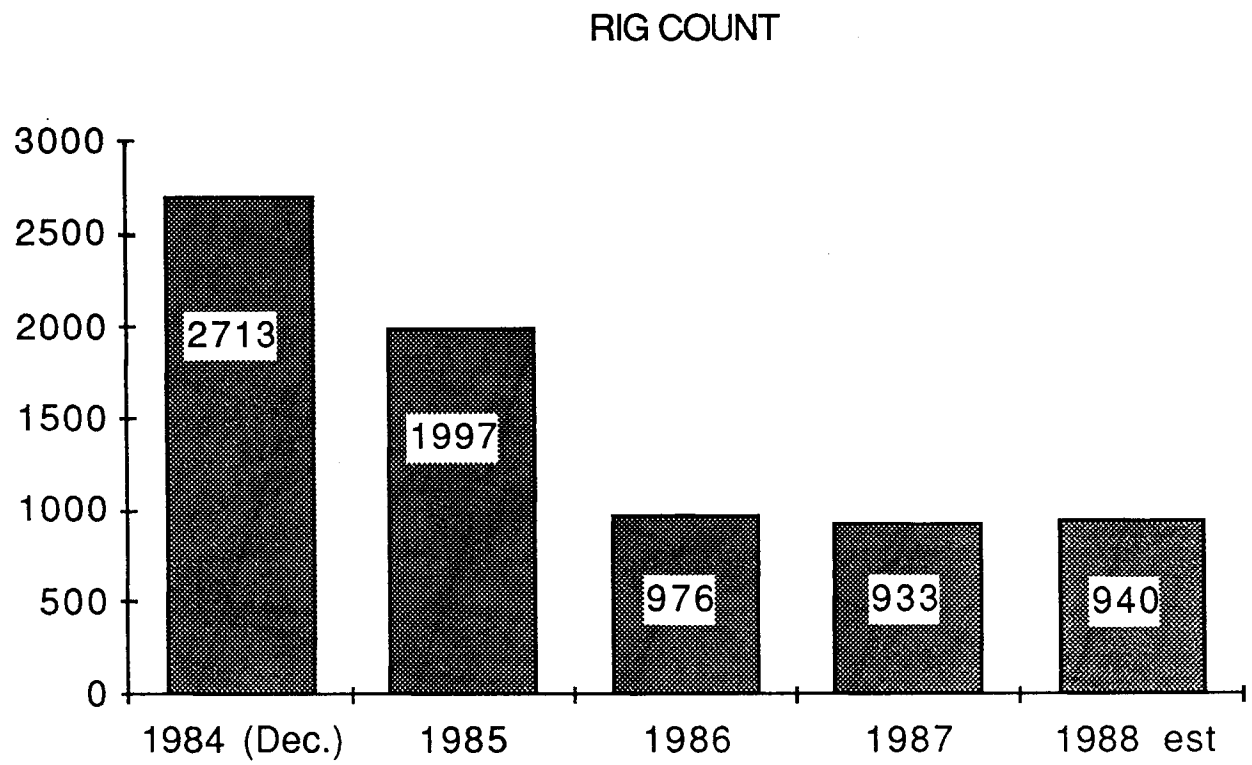


Fig. 3 Trap types and reservoir lithologies.

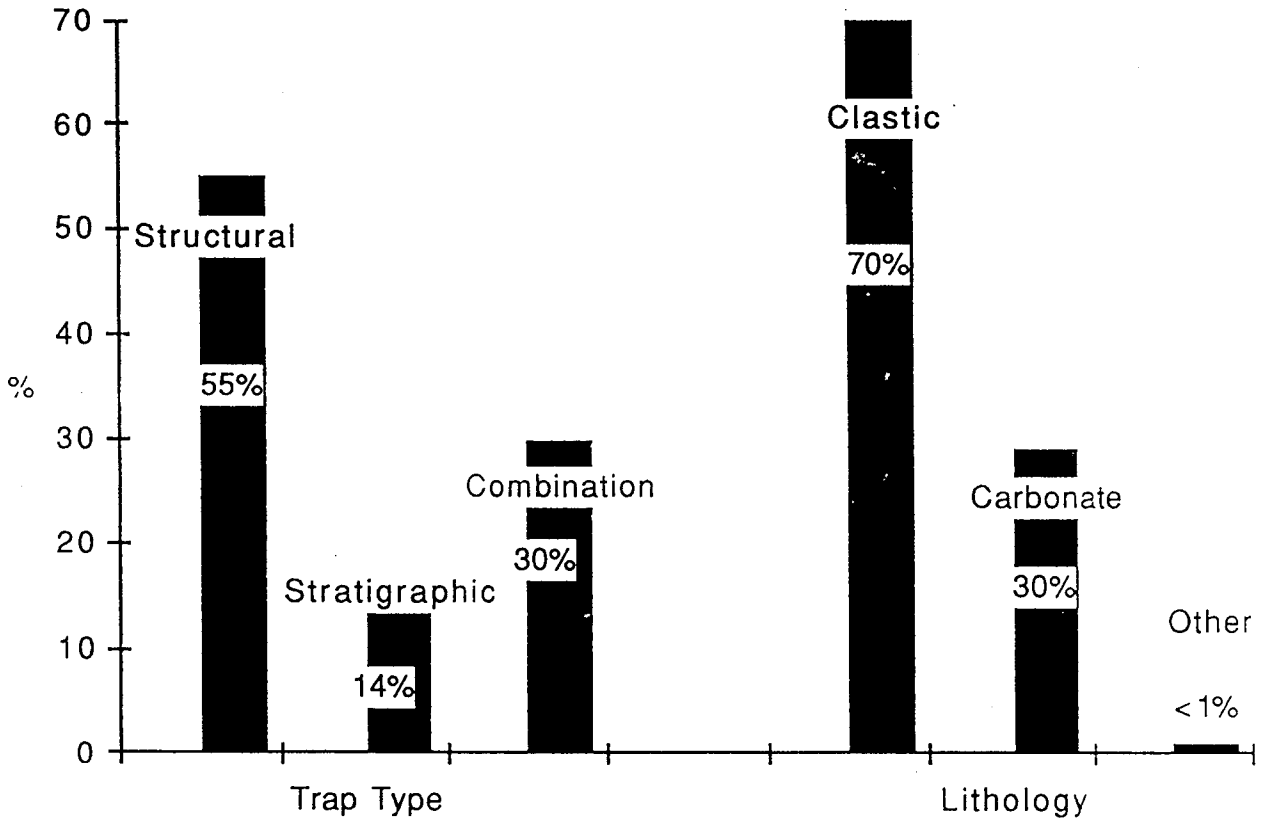


Figure 4

WELLS NECESSARY TO DISCOVER VARIOUS FIELD SIZES.

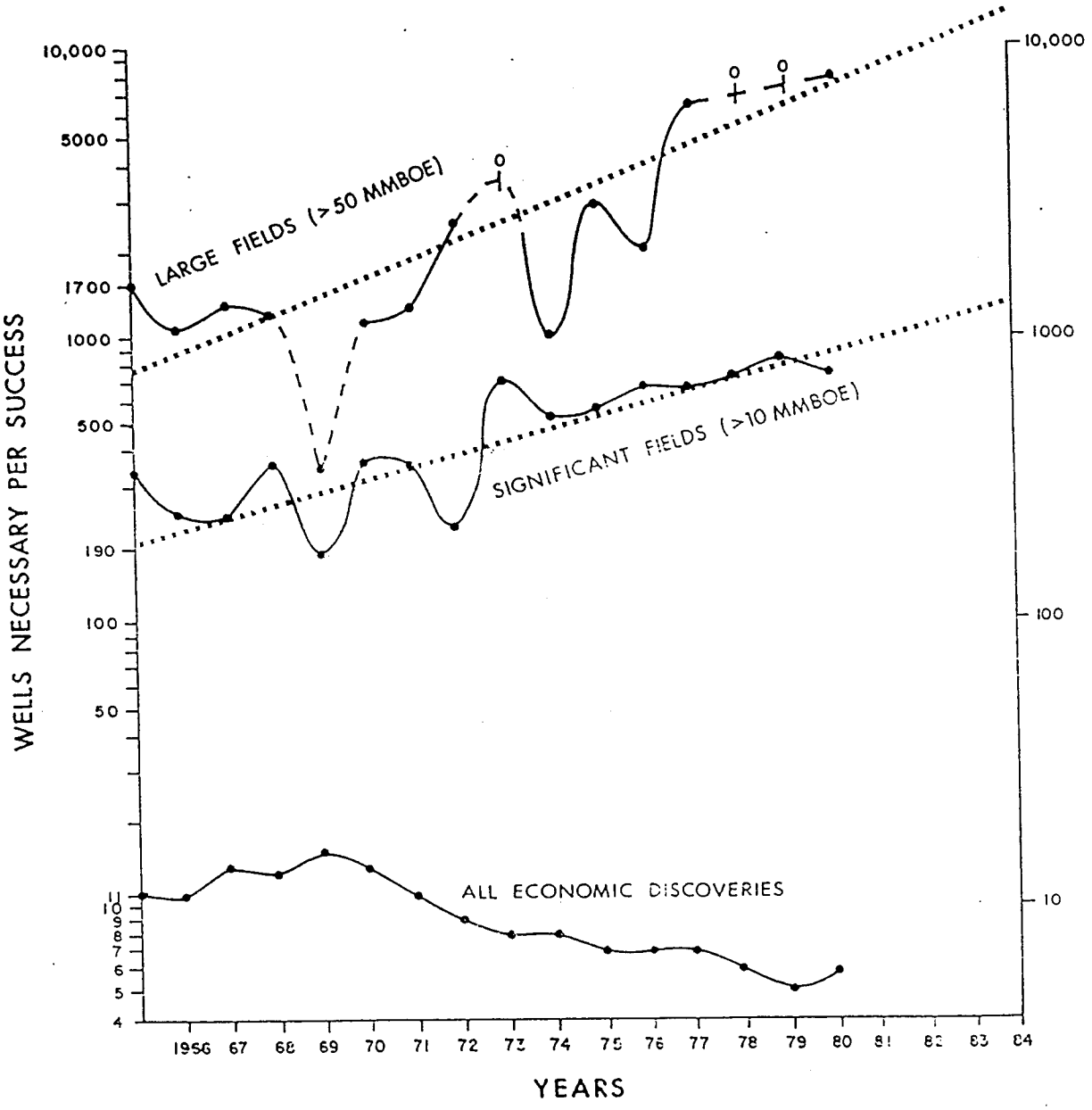


Figure 5A

AVERAGE TAX RATE ON ASSESSED VALUE OF RURAL TANGIBLE PROPERTY -- 1973

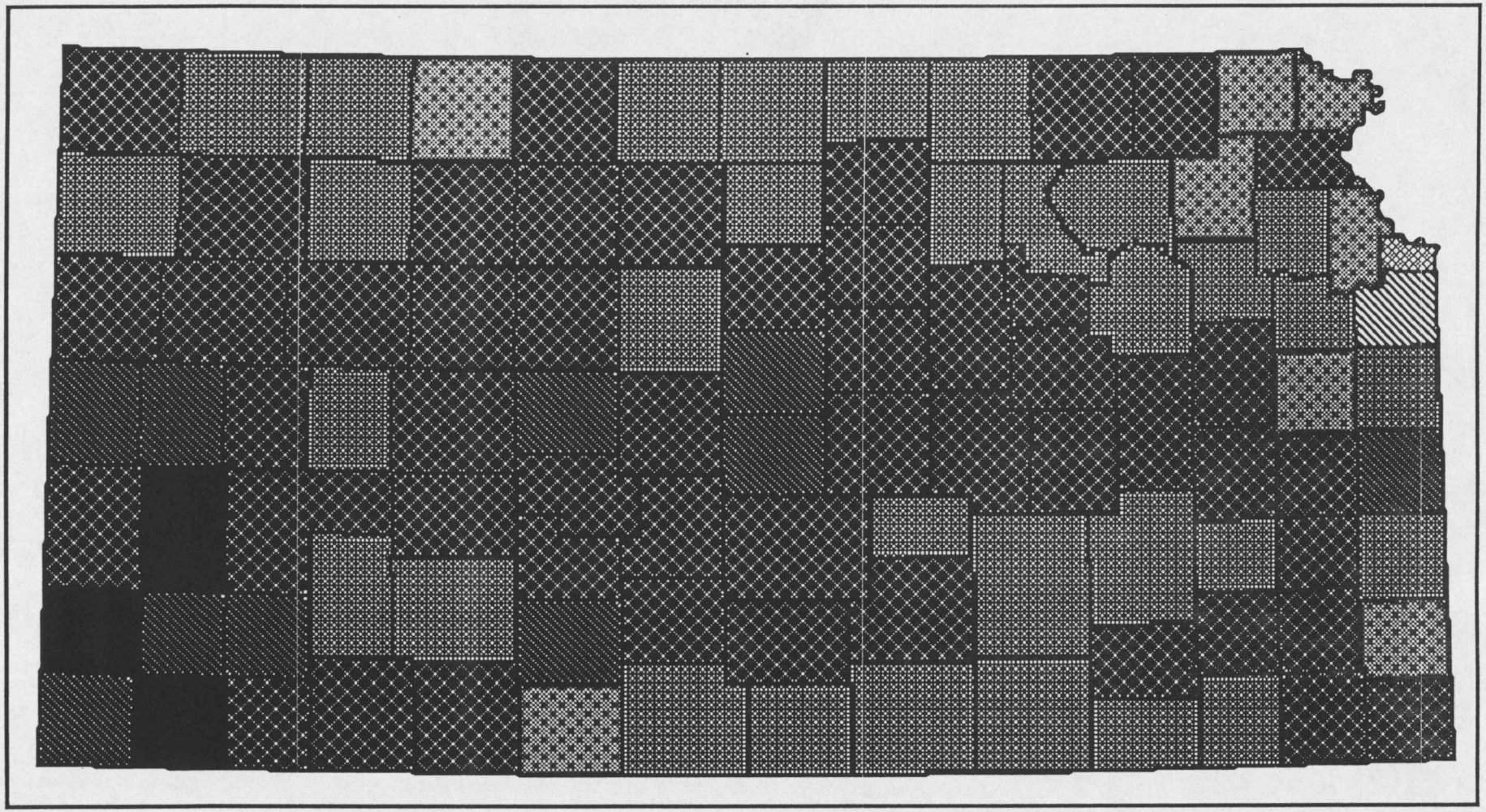
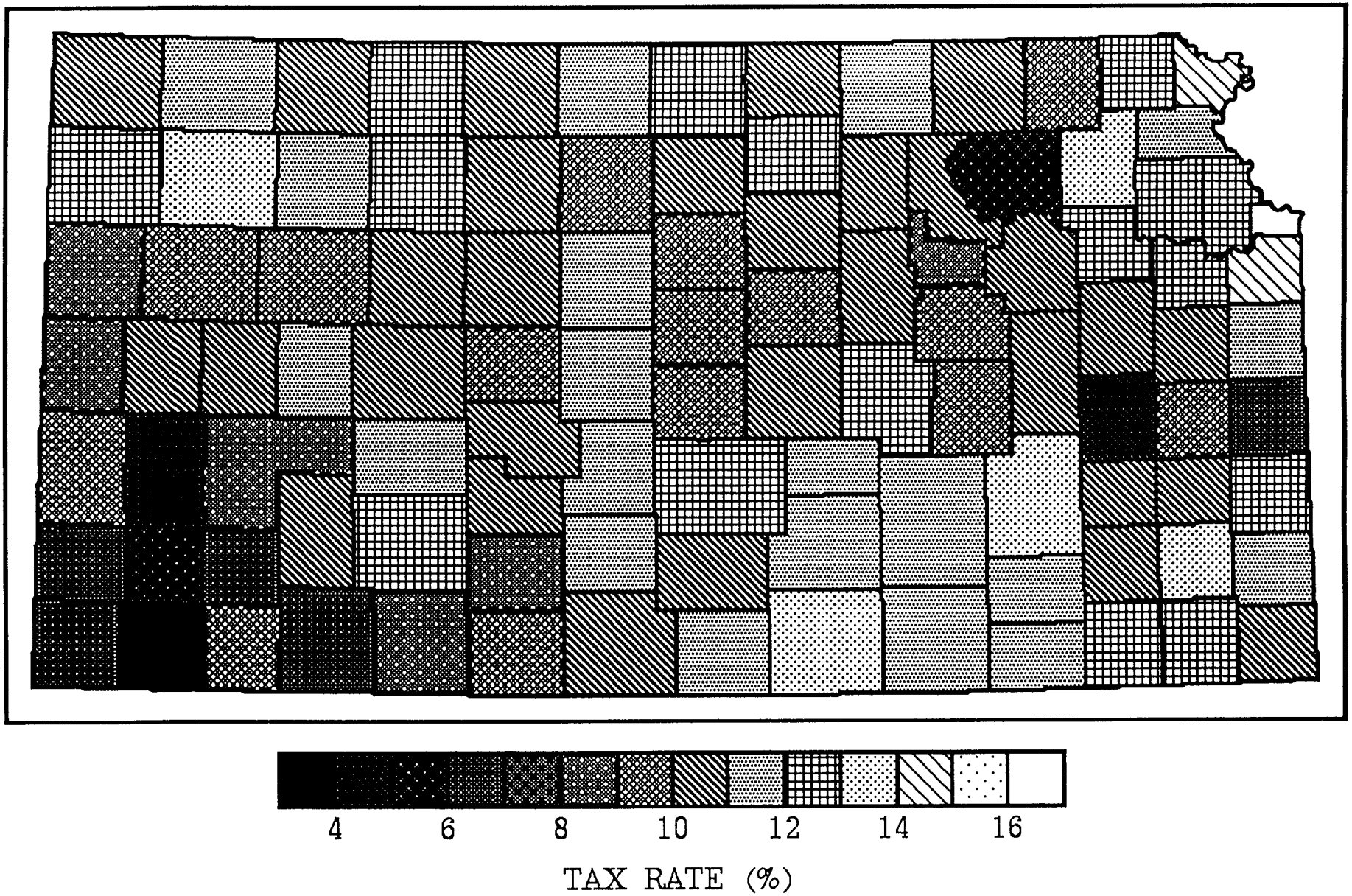


Figure 5B

AVERAGE TAX RATE ON ASSESSED VALUE OF RURAL TANGIBLE PROPERTY -- 1987



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