DOE/EIA-0575(94)

Oil and Gas Resources of the Fergana Basin (Uzbekistan, Tadzhikistan, and Kyrgyzstan)

December 1994

Energy Information Administration
Office of Oil and Gas
U.S. Department of Energy
Washington, DC 20585

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Response to this report is certainly invited, particularly regarding data for other oil and gas provinces in the former Soviet Union.

Diskette Information

Reservoir-level data are available in spreadsheet files on a single computer diskette. Either a 3.5-inch or a 5.25-inch diameter diskette is available. These files were prepared as part of the Advance Summary for this report, published in December 1993. The same data were used for the Advance Summary and this full report. The data encompass estimated and reported reservoir parameters and resulting volumetric analyses of oil and gas. Twelve separate files are stored on the diskette. One file provides introductory text, English-metric conversion units, and several engineering/geological relationships that were used. Eleven files provide basic information, parameter values for reservoirs and oil and gas, and estimated oil and gas quantities. Both English and metric unit values are included. The one text file is in ASCII format. The eleven spreadsheet files are in LOTUS *.WK1 format. There is no charge for the limited quantities of this diskette. Feedback from the user to the authors would be helpful for future electronic data products of this type.

The diskette, labeled "Fergana Basin, November 1993," is available from the Dallas Field Office of the Energy Information Administration (EIA). Please contact Gary Long, telephone 214/767- 0882, or fax 214/767-2204.

Released for Printing:

Preface

This work is part of the Energy Information Administration's (EIA's) Foreign Energy Supply Assessment Program (FESAP). Before publication of this report and its Advance Summary (December 1993), EIA had not prepared a FESAP oil and gas report for any part of the former Soviet Union. *Oil and Gas Resources of the Fergana Basin (Uzbekistan, Tadzhikistan, and Kyrgyzstan)* represents a trial assessment of reservoir-level data that had begun to be collected before breakup of the Soviet Union in 1991. Such data were much more sparse then, than now, and estimated quantities relate to the end of 1987.

This study is different from previous FESAP analyses, in that reservoir-level parameters were used to calculate oil and gas quantities which were aggregated to the field level, then to four sub- basin areas, and finally to the Fergana basin level. Reservoir-level data are listed in Appendices A, E, and F of this report, and in files on the available computer diskette. It was necessary to fill many omissions in the source data by estimating various reservoir parameters, including important net pay thicknesses and areal extents. Thus, while data accuracy is not claimed, this report is nevertheless the most comprehensive public assessment that is available for the entire Fergana basin.

Compared to other petroleum provinces of the former Soviet Union, the Fergana basin has relatively small quantities of remaining recoverable oil and gas. For example, estimated quantities are about 0.7 billion barrels of discovered oil reserves, and about 3.0 billion barrels of undiscovered oil. Future oil and gas production from the Fergana basin will not affect world markets. However, such recoverable quantities are important to the republics of Uzbekistan, Tadzhikistan, and Kyrgyzstan, to their peoples, and to their oil and gas operating associations. Bids for license blocks were solicited for the first time in the basin by Uzbekistan in August 1993, and future solicitations are planned by Kyrgyzstan. Therefore, independent estimates of recoverable oil and gas in this report and its Advance Summary are particularly useful to international operating companies. Use of this report is also intended for organizations with international activities such as financial institutions and several agencies of the U.S. Government.

This assessment, with its collection of data and information, was initiated by co-author James W. Clarke, while in the World Energy Resources Program of the U.S. Geological Survey. Dr. Clarke's considerable contributions are also recognized in translating both the words and the concepts from Russian language sources into the English language. Draft report reviews by several petroleum geologists and petroleum engineers in the private sector were performed, and their beneficial contributions are gratefully acknowledged.

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Executive Summary

This analysis, prepared in cooperation with the U.S. Geological Survey (USGS), is part of the Energy Information Administration's (EIA's) Foreign Energy Supply Assessment Program (FESAP). While past FESAP analyses cover most of the major oil and gas provinces of the world, this one for the Fergana basin is an EIA first for republics of the former Soviet Union (FSU). This was a trial study of data availability and methodology, resulting in a reservoir-level assessment of ultimate recovery for both oil and gas. Ultimate recovery, as used here, is the sum of cumulative production and remaining Proved plus Probable reserves as of the end of 1987. Reasonable results were obtained when aggregating reservoir-level values to the basin level, and in determining general but important distributions of across-basin reservoir and fluid parameters. Plans are underway for other assessments of basins in the FSU. However, future FSU basin assessments by EIA will probably be based on field-level detail.

A 14-page Advance Summary of this analysis was published in December 1993. With its computer diskette of spreadsheet data files, the summary was available prior to the announced January 1994 close of competitive bidding in Uzbekistan, for oil and gas license blocks covering most of the basin. In July 1994, the republic of Kyrgyzstan also offered oil and gas blocks for bid. While no Kyrgyz blocks were offered in the Fergana basin by December 1994, such an offering is expected. Kyrgyzstan has announced its intention to offer Fergana basin blocks within the next few years. Currently, this report represents the most comprehensive assessment publicly available for oil and gas in the Fergana basin. Unfortunately, no new data have been added to those used for the Advance Summary. This full report uses the same engineering data as collected and estimated for the Advance Summary, including spreadsheet data on the accompanying diskette. This full report provides additional descriptions, discussions and analysis illustrations that are beneficial to those considering oil and gas investments in the Fergana basin.

Table ES1 presents summary estimates for oil resources of the Fergana basin, through 1987. Separate estimates of gas condensate were not performed in this assessment and as used here, "oil" does not include condensate from gas reservoirs. The estimated quantity of both discovered and undiscovered recoverable oil in the Fergana basin is 4.0 billion barrels, which is equivalent to about 19 months of U.S. oil production. Of 1.0 billion barrels of oil discovered, about 0.7 billion barrels are estimated as remaining Proved and Probable reserves. The Mingbulak field accounts for 25 percent of these remaining Proved and Probable oil reserves in the Fergana basin. Mingbulak was the site of a large oil well blowout in 1992, which focused Western explorationist's attention on the basin. Oil and gas have not been successfully produced from the Mingbulak field. This field, located in the central basin graben, was not part of the license blocks offered by Uzbekistan in August 1993. The USGS's estimated modal value for undiscovered recoverable oil, at 3.0 billion barrels, mainly includes additional Mingbulak-type fields in the deep central basin graben.

Table ES1. Estimated Oil Resources of the Fergana Basin, as of the End of 1987 (billion barrels)

Discovered Oil	
Original in Place	4.538
Cumulative Production	0.365
Remaining Recoverable Reserves (Proved and Probable)	0.653
Discovered Ultimate Recovery (cumulative production + reserves)	1.018
Undiscovered Recoverable Oil	
Historical Trends Projection	0.300
Potential of New Plays (primarily deep central graben)	2.700
USGS Total Undiscovered (modal value, end 1991)	3.000
Total Recoverable Oil (discovered and undiscovered)	4.018

The estimated quantity of both discovered and undiscovered recoverable nonassociated gas in the basin is 4.8 trillion cubic feet, which is equivalent to about 4 months of U.S. production of nonassociated gas. Of 1.8 trillion cubic feet of discovered nonassociated gas, roughly 1 trillion are estimated as remaining Proved and Probable reserves. The USGS's estimated modal value for undiscovered recoverable nonassociated gas is 3.0 trillion cubic feet, and like oil, mainly includes additional Mingbulak-type fields in the deep central basin graben.

While oil pipelines exist within the basin, and there are gas pipelines exiting the basin, no pipelines export oil from the basin. The two oil refineries in the basin are operating at less than capacity. Our estimate of the basin's oil production in recent years is 6 to 7 million barrels annually. Even with an introduction of Western investment capital and applied technology, a gradual development of the basin's remaining oil resources is predicted. As indicated by **Figure 17** (in the main body of the report), the two different projection methods show optimistic peak oil production rates from slightly over 30 to slightly over 50 million barrels per year. Both projection methods in this scenario assume a total oil recovery of 4 billion barrels since initial discovery in 1901.

The estimate of peak (plateau) oil production, using the constant rate projection method (near 30 million barrels per year), occurs about the year 2025. The estimate of peak oil production, using the logistic function projection method (near 50 million barrels per year), occurs about the year 2045. In essence, if such peak production rates are to be achieved, a substantial infusion of investment capital is considered necessary. This capital infusion would be for discovering, developing, and exporting new oil resources, and would primarily include oil estimated to reside in the deep, hostile, subsurface environment of the central basin graben.

1. Analysis of Oil and Gas Resources in the Fergana Basin

Background

The Energy Information Administration (EIA), in cooperation with the U.S. Geological Survey (USGS), has assessed 13 major petroleum producing regions outside of the United States. This series of assessments has been performed under EIA's Foreign Energy Supply Assessment Program (FESAP). The basic approach used in these assessments was to combine historical drilling, discovery, and production data with EIA reserve estimates and USGS undiscovered resource estimates. Field-level data for discovered oil were used for these previous assessments. In FESAP, supply projections through depletion were typically formulated for the country or major producing region.

Other than the Advance Summary of this report, EIA has not prepared an assessment of oil and gas provinces in the former Soviet Union (FSU). Before the breakup of the Soviet Union in 1991, the Fergana basin **(Figure 1)** was selected for a trial assessment of its discovered and undiscovered oil and gas. The object was to see if enough data could be collected and estimated to perform reasonable field-level estimates of oil and gas in this basin. If so, then assessments of other basins in the FSU could be considered. The objective was met and assessments of other basins are being considered. Collected data for this assessment cover discoveries through 1987.

In this Chapter 1 and in the appendices to this report, assessments deal almost entirely with *discovered* oil and gas. USGS estimates of undiscovered recoverable oil and gas are addressed in **Table 1** and in the last section of this chapter *(Oil Supply Projections)*. Chapter 2 of this report describes petroleum geology of the Fergana basin.

When Uzbekistan announced its first international offering of oil and gas license blocks in August 1993, 5 of the 10 blocks offered for exploration and development were in the Fergana geologic basin. Together these blocks extend across most of the valley area of the Fergana basin. Recognizing the benefits to Western oil and gas organizations, and possibly to the republics of Uzbekistan, Tadzhikistan, and Kyrgyzstan, EIA updated its preliminary basin study. This update mainly stems from reports in 1992 and later, of the large oil well blowout at Mingbulak field. The blowout was from a deep Miocene sandstone reservoir in the central basin graben. Additional updates were taken from the USGS August 1993 basin-level estimates of oil and gas resources in the FSU, as published in USGS Open-File Report 93-316. (A comparison of estimate summaries is presented in **Table 1.**) Bidding for the Uzbek blocks was announced to close January 17, 1994, but a few negotiations are understood to be continuing beyond that date.

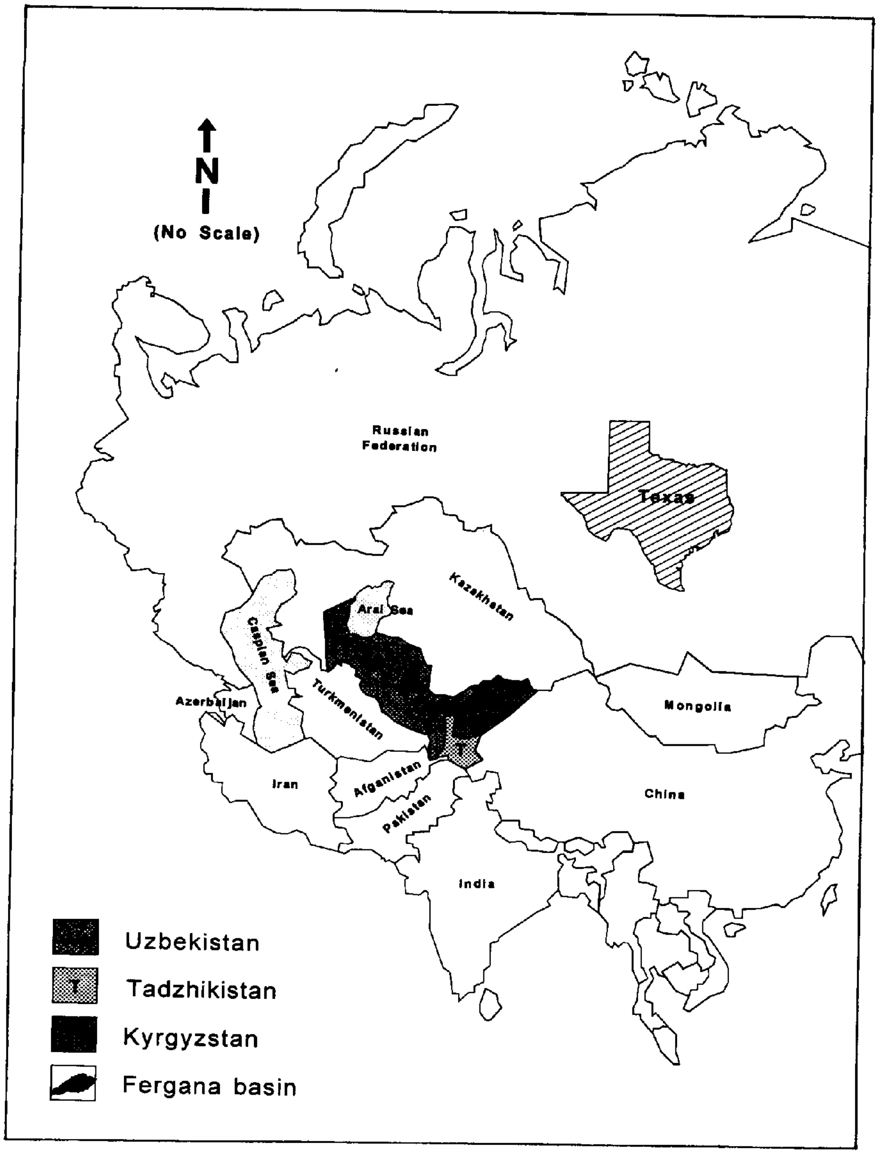
In addition, in June 1994, the republic of Kyrgyzstan announced future offerings of 12 concession blocks across its territory. A Kyrgyz presentation conference occurred in Houston, Texas, during July 18 through 20, 1994. Kyrgyz areas of the Fergana basin were not included in the four blocks then offered, which were generally east of the basin. However, Fergana basin blocks are intended to be offered by Kyrgyzstan in the future.

Since the Advance Summary report of this assessment was published in December 1993, no new data on discovered oil and gas have been collected or analyzed. Additional information provided by this full report are primarily: (a) inclusion of a petroleum geology section; (b) inclusion of a section projecting potential oil supply; and (c) additional discussion with illustrations regarding distributions of reservoir parameters and oil and gas discovered through 1987.

Basic Results

In geographic size, the Fergana basin is relatively small, compared to most other oil and gas provinces in the FSU. Also by this comparison, the basin's oil and gas fields are relatively small in number and geographic size. However, with recent emphasis given to the central graben as a result of the relatively large Mingbulak field, the basin's oil and gas potential has

Figure 1. Diagrammatic Location Map of Countries Surrounding the Fergana Basin, West-Central Asia (superimposed Texas area)



Note: General area of the State of Texas superimposed on Russia's Siberia for rough size comparisons. Texas-area comparisons apply only to the immediate Fergana basin region, as scales vary across this diagrammatic map.

Source: Energy Information Administration, Office of Oil and Gas

Table 1. Estimate Summary and Comparison with Other Estimates, Fergana Basin (through 1987)

Reported Component	USGS Contractor, Total Basin as of End 1973	Zhabrev, 17 Fields as of End 1979	Meyerhoff, Total Basin as of End 1981	Dikenshteyn, Total Basin, as of End 1982(?)	This Fergana Basin Report, Total Basin as of End 1987	Petro-consultants, Total Basin as of End 1991	USGS Open-File Report 93-316, Total Basin as of End 1991
Discovered Original Oil In Place (million barrels)	--	--	--	--	**4,538**	--	--
Cumulative Oil Production (million barrels)	--	--	465	334	**365**	[a]392	400
Discovered Ultimate Oil Recovery (million barrels)	[b]242	--	--	--	[c]**1,018**	783	1,400
Remaining Oil Reserves (million barrels)	--	--	--	100	**653** (Proved and Probable)	--	[d]1,000 (Identified)
Discovered Original Non-associated (NA) Gas In Place (billion cubic feet)	--	--	--	--	**2,403**	--	--
Cumulative Gas Production (billion cubic feet)	--	478	210	706	**780**	880	1,000 (NA gas)
Discovered Ultimate Gas Recovery (billion cubic feet)	[b]1,574	[b]987	--	--	[e]**2,364**	1,720	1,300 (NA gas)
Undiscovered Recoverable Non-associated (NA) Gas (billion cubic feet)	--	--	--		**3,000** (mode)	--	[f]3,000 (mode)
Undiscovered Recoverable Oil (million barrels)	--	--	--	--	**3,000** (mode)	--	[f]3,000 (mode)

[a]Includes condensate production.

[b]Former Soviet classification of remaining reserves (A + B + C_1) summed with cumulative production. In U.S. reserves terminology, A + B + C_1 roughly equates to Proved and Probable reserves.

[c]Applied individual primary oil recovery efficiencies and waterflood recovery efficiencies to estimates of original oil in place, reservoir-by-reservoir. The primary recovery portion is estimated to be 927 million barrels of oil; the improved recovery by waterflooding is estimated to be 91 million barrels of oil. Estimates for the Mingbulak field account for 165 million barrels (16.2 percent) of the basin's ultimate recoverable oil.

[d]USGS "Identified" reserves approximately include economically recoverable Proved, Probable, and Possible reserves (including reserve increases by physical field growth and/or improved recovery).

[e]Applied individual gas recovery efficiencies to estimates of original gas in place for reservoir-by-reservoir sum of 1,780 billion cubic feet of nonassociated gas. Applied individual gas-oil ratios to estimates of oil recoverable by primary and waterflood mechanisms for reservoir-by-reservoir sum of 584 billion cubic feet of associated-dissolved gas. Estimates for Mingbulak field account for 574 billion cubic feet (24.3 percent) of the basin's ultimate recoverable gas (both nonassociated and associated-dissolved gas).

[f]Modal values are more applicable for single-point estimates here. USGS mean values for undiscovered recoverable nonassociated gas are 3,300 billion cubic feet and for oil, 4,200 million barrels.

Notes: Quantities are assumed to be at surface conditions. Position of values not estimated or not reported is indicated by the double dash symbol (--). Totals may not equal sum of components due to independent rounding.

Sources: Energy Information Administration, Office of Oil and Gas. James W. Clarke, retired U.S. Geological Survey, World Energy Resources Program. Other estimate sources are identified in the *Selected References* section.

significantly increased. At least 7 fields are assumed to have been discovered after 1987, in addition to the 53 fields analyzed.

Natural gas is an important regional commodity and some gas is exported from the Fergana basin. Discovered and undiscovered recoverable nonassociated gas in the basin is estimated to be about 4.780 trillion cubic feet (1.780 trillion discovered, 3 trillion undiscovered). Of the discovered quantity, about 1 trillion cubic feet are roughly estimated as remaining Proved and Probable nonassociated gas reserves. As with oil, estimates of remaining nonassociated gas reserves also rely on quantities determined as cumulative historical gas production (used, flared, or vented). Reservoir-level, field-level, or even basin-level oil or gas production histories were not available. Thus, additional difficulties are involved for estimating remaining reserve quantities.

The term "ultimate recovery " applies here only to discovered quantities of oil and gas, and not to estimates of undiscovered quantities. Typically, ultimate recovery is the sum of cumulative production and remaining discovered reserves.

The ultimate recovery of associated-dissolved natural gas in the Fergana basin is estimated to be about 0.584 trillion cubic feet. This is gas that was contained in discovered oil reservoirs, and was simplistically estimated by applying gas-oil ratios at the reservoir level. A separate estimate of undiscovered associated-dissolved gas was not prepared.

Discovered and undiscovered recoverable oil in the Fergana basin are estimated to be about 4.018 billion barrels (1.018 billion discovered, 3 billion undiscovered). Of the discovered quantity, about 0.653 billion barrels are estimated as remaining Proved and Probable oil reserves.

The Mingbulak field, with about 0.165 billion barrels of oil estimated as recoverable from 3 overpressured reservoirs, alone accounts for about 16 percent of the basin's ultimate recoverable oil. This field, which is not being produced, also accounts for about 25 percent of the basin's remaining Proved and Probable oil reserves. One overpressured gas condensate reservoir, with estimated Proved and Probable reserves of about 344 billion cubic feet gas, was assessed for Mingbulak field. This Paleocene gas condensate reservoir contains about 19 percent of the basin's ultimate recoverable nonassociated gas reserves. An oil well in the Mingbulak field was the site of a significant blowout in 1992, which focused Western explorationist's attention on the deep, Tertiary-age section in the central basin graben. Oil and gas estimates for this field were based upon data extrapolations from the blowout well, one other well, and structural closure.

Assessed Categories

A world-class giant field is defined as one originally containing 500 million barrels or more of recoverable oil or equivalent gas. With an estimate of about 261 million *equivalent* barrels of recoverable oil, Mingbulak is not in the category of a world-class giant. However, with development of as many as eight reservoirs, Mingbulak has the future potential of becoming a giant field. The next largest Fergana oil field size estimated is about 124 million barrels of ultimate recoverable oil, in the Sharikhan-Khodzhibad field, discovered in 1948. Mingbulak also has the largest Fergana field size for nonassociated natural gas, with about 344 billion cubic feet of ultimate recoverable gas. The next largest Fergana field size for nonassociated natural gas is about 246 billion cubic feet of ultimate recoverable gas estimated for the Niyazbek-Karakchikum field, discovered in 1974.

As previously noted, "ultimate recoverable" oil and/or gas is the sum of cumulative production and remaining reserves, and is also referred to by some as "original recoverable reserves." Ultimate recoverable quantities presented in this report basically result from applying recovery efficiencies to volumetric estimates of original oil and gas in place, reservoir-by-reservoir. The categories of oil and gas estimated as ultimately recoverable are the nearest to original Proved plus Probable reserves in U.S. terminology, which roughly match the FSU categories of A + B + C_1. Simplistically, the FSU category "A" can be considered as reserves developed and currently being produced; "B" as reserves drilled and tested but not being produced; and "C_1" as partially evaluated but undeveloped reserves, such as that portion of a reservoir that has been delineated by exploration drilling. Also, the word "oil" as used in this report does not include condensate from gas reservoirs. No separate estimates were prepared for gas condensate, either from crude oil reservoirs, gas reservoirs, or gas condensate reservoirs.

Various counts of oil and gas reservoirs are presented in the report (such as 53 fields with an aggregate of 177 reservoirs). These counts, from various fields, do not imply that 177 reservoirs extend continuously across the basin. The use of the term "pay zone" is intended to mean extensive formational zones often containing oil and/or gas in commercial quantities. For example, some 30 pay zones are recognized within the Fergana basin, and have been locally identified by Roman numerals. Not all of these pay zones will exist in any one field, and of those that do, all may not be productive.

It is pointed out that recovery efficiency correlations and other correlations leading to estimates of original Proved plus Probable reserves stem from applications of U.S. technology, equipment, and field practices. These applications are not the same as those currently used in the Fergana basin. For example, multi-zone completions or recompletions of a single well are often done in the United States; these operations are seldom done in the Fergana basin. Thus, EIA estimates of ultimate recovery presented here (original Proved plus Probable reserves) may be optimistic. Contrary to this hypothesis are two different estimates for recoverable oil at the Mingbulak field: (a) EIA's is about 165 million barrels for 3 reservoirs; and (b) Uzbekistan's is about 416 million barrels of "estimated reserves" for up to 8 reservoirs (57 million metric tons, Uzbek handout material of August 1993, assumed at 32.7 degrees API gravity). Some of these 8 "reservoirs" are only untested "shows" (occurrences) encountered during drilling, and it is doubtful if economic considerations were applied for the 416 million barrel estimate. Additionally, for its estimates of recoverable oil in the Mingbulak field, Uzbekistan has included reservoir areas that have not been delineated by drilling (the C_2 reserves category of the FSU). In this assessment, C_2 reservoir areas for Mingbulak field are also included by EIA in estimating Probable reserves as a special case for comparison purposes, although only a handful of wells have been drilled near the field's anticlinal crest. C_2 reserves are not included in EIA estimates for the rest of the Fergana basin.

Data Used

Available Data

Published sources do not provide sufficient data for direct calculation of original oil and gas in place or recoverable quantities. Therefore, considerable estimating was necessary for many reservoir parameter values. Reservoir parameter data were needed for the simple volumetric calculation method applied. Complete historical series of annual production data were sought, but none were obtained. While no collected data were complete, the most useful sources are listed below. A complete list of published sources are in the *Selected References* section of this report.

- *Oil and Gas Fields of the U.S.S.R.* (in Russian), edited by S.P. Maksimov, 1987.
- *Gas and Gas Condensate Fields - Reference Book* (in Russian), by I.P. Zhabrev, 1983.
- "Fergana Depression," in *Tectonics, Formations, and Petroleum Structures (of) Border Depressions, Central Asia and Kazakhstan* (in Russian), by P.V. Glumakov and others, 1988.
- Field and reservoir data from Petroconsultants S.A., Geneva, Switzerland (primarily field cards for 19 fields, issued 1975-1977). Petroconsultants now have considerable, comprehensive, updated data, but these were not in-hand at the time of this trial analysis.
- Valuable personal communications with James R. Byrne of Byrne & Associates, Houston, Texas, during September and October 1993.

In addition to the above listed sources, one of the EIA co-authors of this report attended the Uzbek offering of license blocks (August 25, 1993, in Houston, Texas). At this conference, informative presentations were heard, several personal discussions occurred, and handout materials were obtained. This information and associated contacts increased our understanding of the Mingbulak area and the deep Tertiary section. "Data rooms" were made available by Uzbekistan for the use of potential bidders at the conference; therefore, the EIA representative did not enter such rooms or review those data.

The four concession blocks offered for competitive bidding by Kyrgyzstan in July 1994 were northeast, southeast, and east of the Fergana basin. However, geologic and geophysical information for the Fergana basin was also included in presentations. Another one of EIA's co-authors of this report attended one day of this Kyrgyzstan conference in Houston, and exchanged views with several participants.

Estimated Data

As previously indicated, reservoir-level data are sparse, and some estimation was necessary for various parameters. For example, for a volumetric calculation, the most basic data needed are the reservoir's bulk volume (as the product of area and average net pay thickness). Unfortunately, for this assessment, data for these two basic reservoir parameters are the least reliable. Reservoir areas were estimated from vintage 1975-1977 Petroconsultants maps of only 19 of the 53 discovered fields. Remaining reservoir areas were projected from these maps and diagrammatic sketches found in other material. Average net pay thicknesses were estimated from: (a) Petroconsultants' field cross-sections in the 19 field records; and (b) applying net pay correction factors to both single values and ranges of gross formational thicknesses reported in the Maksimov and Zhabrev references listed previously. Other examples of estimated reservoir and fluid parameters are drive mechanism and water saturation. For all data estimates, systematic methods were performed; however, some judgement was required. Typically, when multiple estimated values (such as individual reservoir sizes) are aggregated, the resultant total can approach a reasonable figure (such as for the basin level).

For many other reservoir and fluid parameters, estimates were performed using formulas and correlations extracted and adapted from petroleum engineering literature and compiled in Appendix B. Additionally, several correlation graphs were developed for this analysis and are displayed in Appendix C. These graphs provide basin-level downhole pressure and temperature gradients, oil recovery efficiencies for sandstone and carbonate reservoirs under gas solution and water drives, and water saturation from permeability-porosity estimates. These correlation graphs were used as guidelines for estimating those reservoir and fluid parameters, as needed.

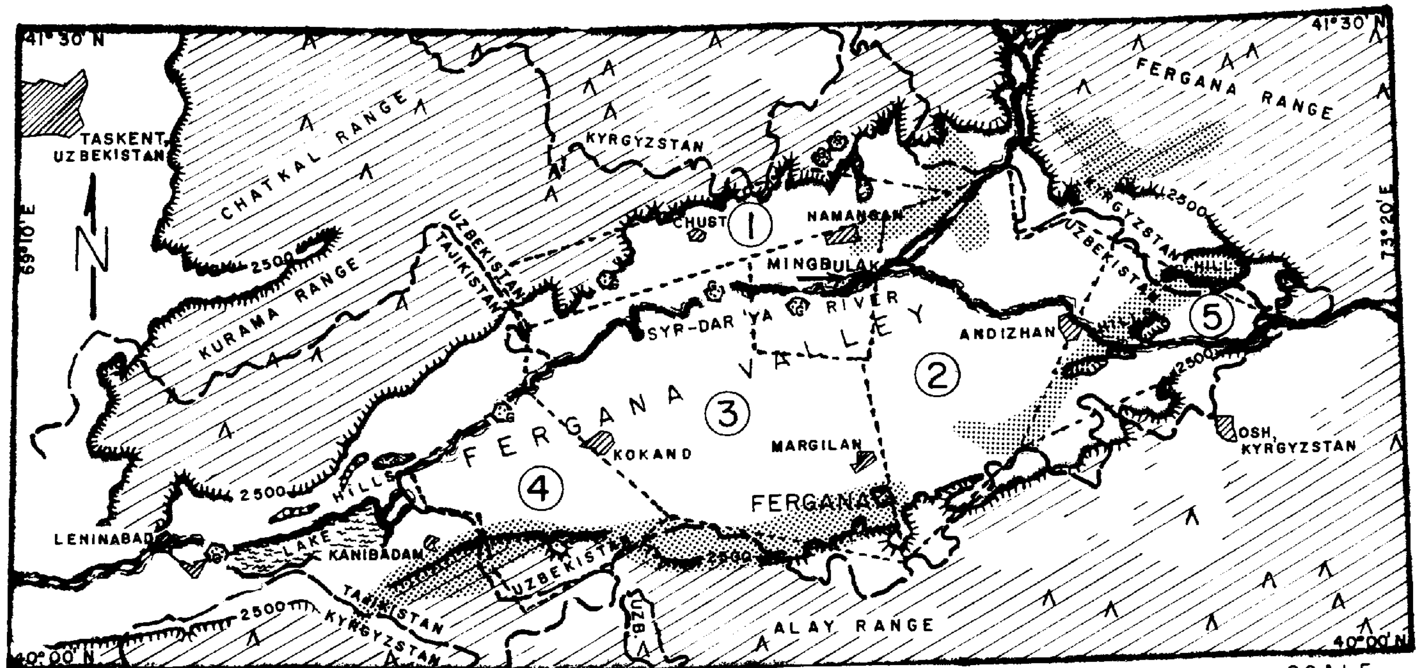
Basin Setting and General Observations

The basin is located in the western portion of central Asia (**Figure 1**). The Fergana structural basin is an extensive, well-populated, east-west trending, intermontane basin. As shown in **Figure 2**, oil and gas fields extend along the basin's 186-mile length (300 kilometers). Maximum topographic relief between the valley floor and the surrounding mountain peaks is about 14,961 feet (4,560 meters). Boundaries of three contiguous FSU republics cross the valley. A part of Tadzhikistan occupies the western, lower end; Uzbekistan covers most of the central and eastern valley floor; and Kyrgyzstan holds the mountain flanks along the valley's northeast, east, and southern fringes. The city of Fergana is in the south-central portion of the valley, in the republic of Uzbekistan.

The Fergana Valley floor, with an altitude of roughly 1,500 feet (457 meters), supports agriculture, which is usually irrigated and is mostly cotton. Two oil refineries are located in the Fergana Valley, and together have an annual crude oil charge capacity of about 64 million barrels (8.6 million metric tons of oil). Natural gas trunk pipelines exit the valley's west end, as do railway and power transmission lines. Oil trunk pipelines do not exit the valley. A viable oil and gas infrastructure exists, but should be visited for one's own evaluation. The infrastructure, including wellsite equipment, is understood to need considerable remedial work.

By the end of 1987, about 53 relatively small oil and gas fields or field combinations had been found in the Fergana basin. Most are located on the basin's southern flank. **Figure 2** also shows the location of the Mingbulak field, in the central basin graben area, along the Syr-Dar'ya River. Judging from review of literature, about 6 of the 53 fields reported are actually combinations of one or more originally discovered oil and gas accumulations (e.g., Chaur-Yarkutan-Chimion), but are referred to in this report as single "fields". For study purposes, we chose to group these 53 fields into the 4 following areas, based upon proximity of surface location and similarity of subsurface geologic structure:

Figure 2. Basic Surface Features of the Fergana Basin Region, with the Five Uzbek License Blocks of 1993



LEGEND:

River.

Approximate boundary of republics.

General trends of oil and gas fields. Locations of 7 scattered gas fields.

2,500-foot (762-meter) topographic contour, with hatched side toward uplands (/ / /).

Various mountain peaks, ranging in altitude from 6,160 to 15,338, feet (1,878-4,675 meters).

Uzbek oil and gas license blocks offered for bids on August 25, 1993, in Houston, Texas.

Source: Energy Information Administration, Office of Oil and Gas (base from Defense Mapping Agency, ONC-F6, 1985)

- north basin flank: 8 oil and 2 gas fields;
- south basin flank (northeast of Fergana): 12 oil and 1 gas fields;
- south basin flank (southwest of Fergana): 15 oil and 4 gas fields; and
- central basin graben (designation by Glumakov, et al, 1988; actually, central and western basin): no gas fields and 11 oil fields, including Mingbulak.

In this oil and gas field tally, a field is counted as oil if only one of its reservoirs contains oil. A field is counted as a nonassociated gas field if all of its reservoirs contain only gas or gas condensate.

The Fergana basin is described as a compressional structural basin, with extensive high-angle reverse faults postulated particularly for its northern flank. Some high-angle overthrusts also occur along the basin's southern flank. The latest large-scale tectonic movements occurred during Miocene-Pliocene (Neogene) time, with high-mountain growth along the basin's margin. Debris shed from these mountains resulted in a molasse of clastic materials in the basin's center. These materials approach a thickness of roughly 26,000 feet (8 kilometers). Most oil-gas discoveries are related to anticlinal traps, which are east-west trending, faulted, and associated with basin-margin tectonics. Fields usually contain multiple reservoirs; 177 commercial reservoirs are reported and analyzed here for the 53 fields. The matrix in **Figure 3** indicates the stratigraphic and field distribution of some 30 "commercial" oil and gas zones from Pliocene (upper Neogene) age to Permo-Triassic age. Such multi-zone, relatively shallow distributions are attractive to explorationists. In the Fergana basin, most shallow pay zones have been found.

One should be aware that "commercial" Soviet parameters applied at the time of **Figure 3** (Glumakov, et al, 1988), do not relate to current world economics. For example, the lack of pipeline export facilities would render most oil and gas discoveries in the Fergana basin as not being competitive in world markets. However, oil and gas markets within the Fergana basin and its region influence considerations for commerciality. Oil and gas pipeline gathering and transport systems, plus oil refineries, exist in the basin and its region.

The average estimated length and width of the reservoirs are only 3.88 by 1.04 miles (6.24 by 1.68 kilometers). Of the 177 reservoirs, 121 were counted as oil productive, and 56 as natural gas and gas-condensate productive. Sandstone and some limestone formations of Miocene down through Eocene age constitute the most productive and extensive pay section in the basin. This is indicated by reservoir-level data and **Figure 3** (Massaget through Alay formations). The Miocene-Eocene section contains about three-fourths of the basin's discovered ultimate oil recovery, whether or not the Mingbulak field is included.

Depths to the top of reservoirs, of the same geological age, range widely. For example, a depth range for Oligocene age reservoirs, across part of the basin, is from 984 feet (300 meters) in the Shorsu-IV field on the southwestern Fergana basin flank to 14,764 feet (4,500 meters) in the adjacent, down-faulted, central basin graben (Varyk-II field). The distance between these example fields, across the southern fault zone, is about 15 miles (24 kilometers). Such variable reservoir depths are noteworthy and are attributed to vertical displacements by faulting, other structural deformation, valley flank-floor elevation differences, variable stratigraphic correlations, depositional slope environments, and the potential for incorrect reporting.

Apparently, little deep exploratory drilling has been performed in the central portion of the Fergana basin for objectives at depths approaching 19,685 feet (6,000 meters). Before the Mingbulak blowout in 1992, the deepest reported reservoir, which contained oil, was at a depth of 16,732 feet (5,100 meters). This deep pay is Eocene Zone VII, an upper carbonate of the Alay beds, found at Varyk-II field located in the western part of the valley, and on a flank of the central basin graben.

While there are exceptions, reservoirs in the Fergana basin are generally of limited areal extent, with an average of only 2,031 acres (8.219 square kilometers). It appears odd that there was not a wider range of reservoir areas that resulted from extrapolation of reported data. In contrast, the average net pay thicknesses of individual reservoirs are good, with the basin average being about 30 feet (9.1 meters). The average reservoir porosities are generally attractive throughout the geologic section, with the average reservoir porosity for the basin being about 16 percent. Structural deformation and depositional environment in this basin can

Figure 3. Pay Zone and Field Distribution of Commercial Oil, Gas, and Condensate in the Fergana Basin (through 1987).

South Flank Fields

SYSTEM	FORMATION	PAY ZONE	Tashravet	Karagachi	Tamchi	Beshkent-Togap	Aksaray	Kim (Sel'rokho)	Obi-Shilo	Nefteabad	Ayritan	Shorsu IV	Shorsu VI	Chongara	Gal'cha	Sokh, North	Rishtan, North	Sarykamysh	Sarytok	Chimion	Yarkutan	Chaur	Khankyz	Avval'	Avval', East	Palvantash, West	Palvantash	Khodzhaosman	Andizhan	Sharikhan-Khodzhiabad	Khartum	Khartum, East	Boston	Alamyshik, South	Alamyshik, North	Changyrtash	Suzak	Chigirchik
NEOGENE	Baktria																									●						●	●				
	Massaget																								●			●				●	●				
PALEOGENE	Sumsar	II-III				●		●	●	●	●	●				●							●			●	●		⊙	●	●	●	●	●	●	●		
	Khanabad Isfara Rishtan	IV	●	●	●							●		●	●	○					●	●					●											
	Turkestan	V						●			●	●		○						●				●	●	●			⊙	●				●		●		
		VI						●				●														●	⊙		⊙	○	○	○		●				
	Alay	VII					○	●			●	●	○	○		⊙							●			●	⊙		●	●	○			●				
	Susak		Non-Productive																																			
	Bukhara	VIII					○					●				●										●	⊙			⊙								
		IX									○	●														●												
		X																																			
CRETACEOUS	Pestrotsvet	XI-XV														●		○									○											
	Yalovach	XVa															○																					
	Ustricha	XVI-XVII															●																					
	Kalacha		Non-Productive																																			
	Kyzyl-Pylyal	XVIIIa-c																																●				
	Lyakan	XVIIIg														○	⊙	○									○	●										
	Muyan	XIX-XXII																												⊙	●		●	⊙			○	
JURASSIC		XXIII-XXIX														○	○	○	○											⊙			○	⊙				○
PERMO-TRIASSIC		XXX																															●					

Central Graben Fields

SYSTEM	FORMATION	PAY ZONE	Niyazbek-Karakchikum	Madaniyat	Makhram	Kanibadam	Ravat	Varyk	Varyk II	Achisu	Gumkhana	Mingbulak
NEOGENE	Baktria										●	
	Massaget										●	●
PALEOGENE	Sumsar	II-III	●	●	●		●	●	●	●		●
	Khanabad Isfara Rishtan	IV	●	●			●	●	●			
	Turkestan	V	●			⊙	●					
		VI	●									
	Alay	VII	◐	●		●	●	●	●			
	Susak		Non-Productive									
	Bukhara	VIII										●
		IX	◐			○	○	●				◐
		X										
CRETACEOUS	Pestrotsvet	XI-XV	◐									
	Yalovach	XVa	◐									
	Ustricha	XVI-XVII										
	Kalacha		Non-Productive									
	Kyzyl-Pylyal	XVIIIa-c										
	Lyakan	XVIIIg										
	Muyan	XIX-XXII										
JURASSIC		XXIII-XXIX										
PERMO-TRIASSIC		XXX										

North Flank Fields

SYSTEM	FORMATION	PAY ZONE	Namangan	Shorbulak	Tergachi	Kassansay	Maylisay	Maylisay IV	Maylisay III	Izbaskent	Izbaskent, East	Bedresay	Kyzyl-Alma
NEOGENE	Baktria												
	Massaget				●			●					
PALEOGENE	Sumsar	II-III				●		●	●	●			
	Khanabad Isfara Rishtan	IV											
	Turkestan	V	●	●	●		●	●	●	●	●		
		VI											
	Alay	VII			●			●	●	●	●		
	Susak		Non-Productive										
	Bukhara	VIII											
		IX						●		●			
		X								●			
CRETACEOUS	Pestrotsvet	XI-XV						⊙		○			
	Yalovach	XVa						●					
	Ustricha	XVI-XVII						○					
	Kalacha		Non-Productive										
	Kyzyl-Pylyal	XVIIIa-c											
	Lyakan	XVIIIg								○		○	
	Muyan	XIX-XXII											
JURASSIC		XXIII-XXIX											●
PERMO-TRIASSIC		XXX											

Note: Other than those fields shown above, there are at least 5 additional fields as noted in material presented by Uzbekistan at its license block offering (August 25, 1993, Houston, Texas); 2 other new fields are reported by Petroconsultants. These 7 fields were probably discovered after 1987: Iskovat (Uzbek block 1); Alty-Aryk, Karadzhida, Khankyz Sever-N, Rishtan Yuzh-S (Uzbek block 3); and Sary-Kurgan, Yaipan (Uzbek block 4). Any new field additions since 1987 are unknown for Uzbek blocks 2 and 5. The 2 Miocene (Massaget) oil reservoirs for Gumkhana and Mingbulak fields were added to this Glumakov matrix as well as the Oligocene (Sumsar) and Paleocene (Bukhara, Zone VIII) oil reservoirs at Mingbulak. Also, a Paleocene (Bukhara, Zone IX) gas condensate reservoir at Mingbulak was substituted for an oil reservoir shown in the original Glumakov matrix.

Source: Modified from Glumakov, et al (1988).

Legend: ● Oil
○ Gas
⊙ Oil and Gas
◐ Condensate

contribute to the types of traps indicated by these basic reservoir parameters. Exploration and development in intermontane basins commonly begin along the flanks. Relatively shallow accumulations of oil and gas along such basin flanks often are a result of migration from deeper sources.

As previously indicated, many fields contain multiple reservoirs. The reservoir-to-field ratio for the entire Fergana basin is about 3.3 (177 reservoirs divided by 53 fields). This simple statistic, coupled with an average reservoir depth of 6,182 feet (1,884 meters), points to some of the reasons for past exploration drilling successes. That is, more than one target reservoir was well within the depth capability of available drilling rigs.

Structural Area, Depth, and Stratigraphic Distributions

The distributions of oil and gas reservoirs regarding their ultimate recoveries, "structural areas", depths, and stratigraphy (i.e., geologic age) are illustrated in **Figures 4, 5, 6, and 7.** These figures essentially provide summary spatial and stratigraphic locations for the basin's discovered oil and nonassociated gas, as of the end of 1987.

As described in the previous section, fields were grouped into four basinal areas, based upon proximity of surface location and similarity of subsurface geologic structure. The distribution of oil and nonassociated gas for these "structural areas" is shown in **Figure 4,** along with the average reservoir depth for each area. Scales and units for the heavy horizontal bars allow direct comparison of barrels oil equivalent (BOE) for oil and nonassociated gas. The south basin flank, both southwest and northeast of the city of Fergana, has about 59 percent of the ultimate discovered oil. These south flank structural areas also have the shallowest average reservoir depths, with 3,241 feet southwest of Fergana and 4,301 feet northeast (988 and 1,311 meters, respectively). Discovered fields on the north basin flank, with an average reservoir depth of 6,529 feet (1,990 meters), have only 13 percent of the basin's ultimate recoverable oil and 29 percent of the ultimate recoverable nonassociated gas.

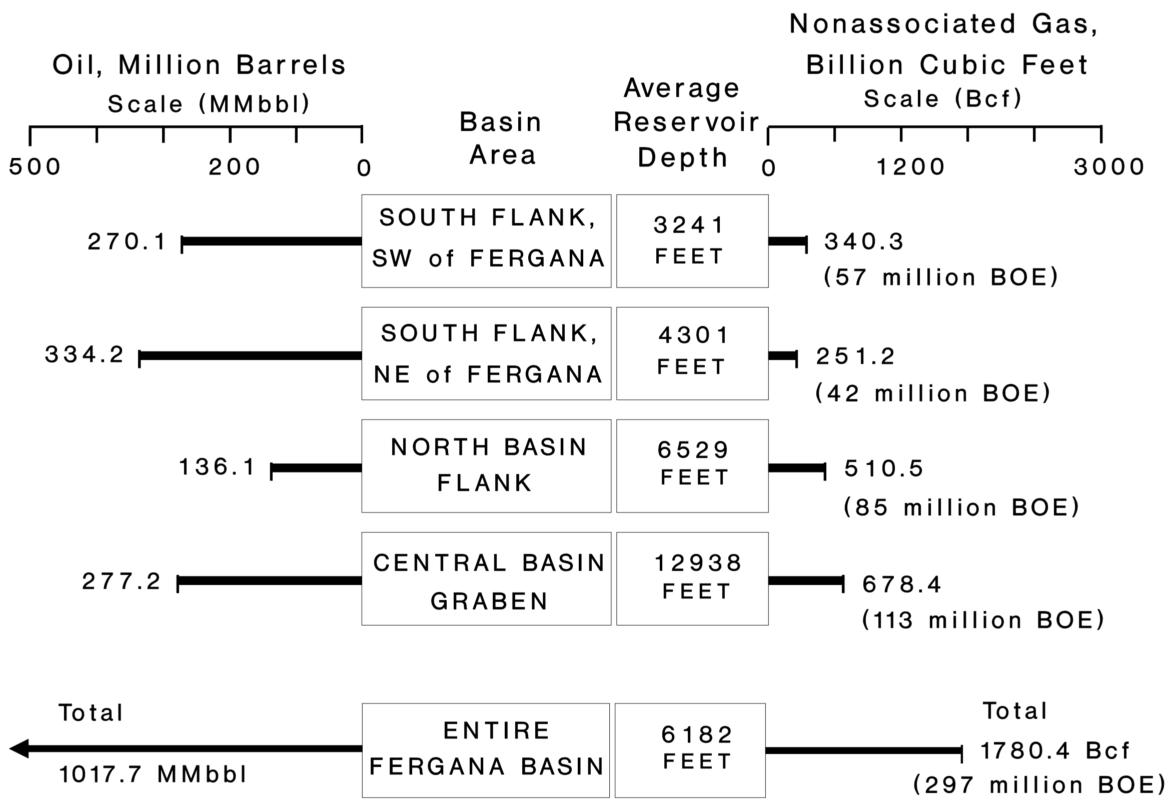
Discovered fields in the central basin graben have about 27 percent of the ultimate recoverable oil and 38 percent of the ultimate recoverable nonassociated gas. Naturally, field reservoirs in the central basin graben are generally deeper than the basin flank fields, with an average reservoir depth of 12,938 feet (3,944 meters). The average depth of discovered reservoirs in the central basin graben is more than twice that for the entire basin.

Figure 5 presents a depth distribution of oil and nonassociated gas for the entire basin, in depth intervals of 4,000 feet (1,219 meters). The number of oil and gas reservoirs is also shown for each depth interval. As in **Figure 4,** scales and units for the heavy horizontal bars allow direct comparison of BOE for oil and nonassociated gas. Of all the depth intervals, the shallowest one (from the surface to 4,000 feet), has the largest proportion of ultimate recoverable oil. This shallowest interval has about 40 percent of the basin's discovered oil. The next deepest interval, from 4,000 to 8,000 feet (1,219 to 2,438 meters) has about 22 percent of the basin's ultimate recoverable oil and about 38 percent of its ultimate recoverable nonassociated gas. Thus, most of the basin's discovered oil and nonassociated gas (58 percent of the BOE) has been found at depths less than 8,000 feet. **Figure 5** also indicates that 70 percent of the basin's discovered oil and gas reservoirs is at depths less than 8,000 feet. New prospects likely remain for discovery or improved recovery at such depths.

The Mingbulak field, with reservoirs in the depth interval of 16,000 to 20,000 feet (4,877 to 6,096 meters), contains almost all of the discovered oil and nonassociated gas for this deepest interval. This depth interval, with only 6 discovered reservoirs, currently is identified with 16 percent of the basin's ultimate recoverable oil and 19 percent of the basin's ultimate recoverable nonassociated gas. Additional discoveries are expected in this depth interval for the central basin graben.

Figure 6 provides a glimpse of oil reservoir depths separated into geologic age groups, for each of the basin's four structural areas. Here, Pliocene-Miocene oil reservoirs are the youngest rocks; pre-Tertiary oil reservoirs are the oldest. For oil reservoirs grouped into

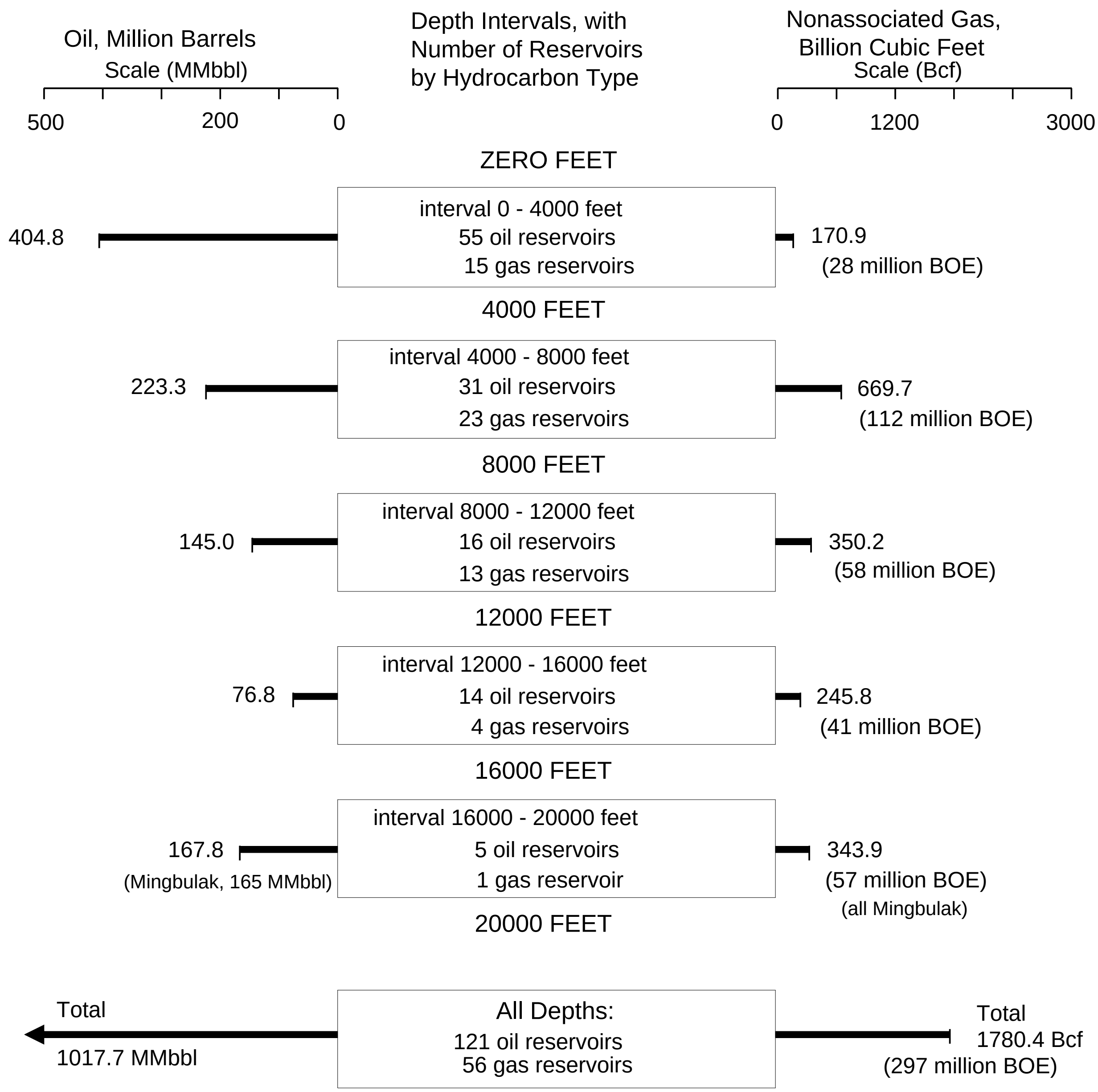
Figure 4. Structural Area Distribution for Ultimate Recovery of Discovered Oil and Gas, Fergana Basin (through 1987)



Note: Bar scales and units for oil and gas are set in order to compare barrels oil equivalent (BOE) at an approximate conversion of 1 barrel oil equals 6000 cubic feet gas. Totals may not equal sum of components due to independent rounding.

Source: Appendix A.

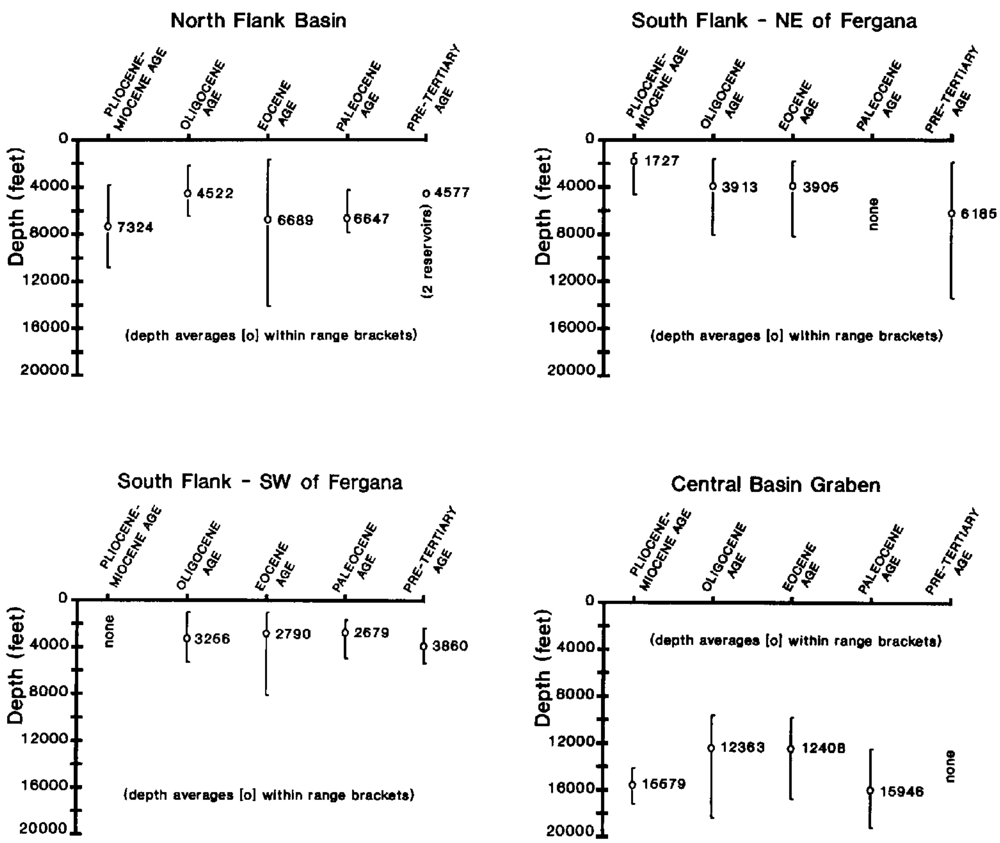
Figure 5. Depth Distribution for Ultimate Recovery of Discovered Oil and Gas, Fergana Basin (through 1987)



Note: Bar scales and units for oil and gas are set in order to compare barrels oil equivalent (BOE) at an approximate conversion of 1 barrel oil equals 6000 cubic feet gas. Totals may not equal sum of components due to independent rounding.

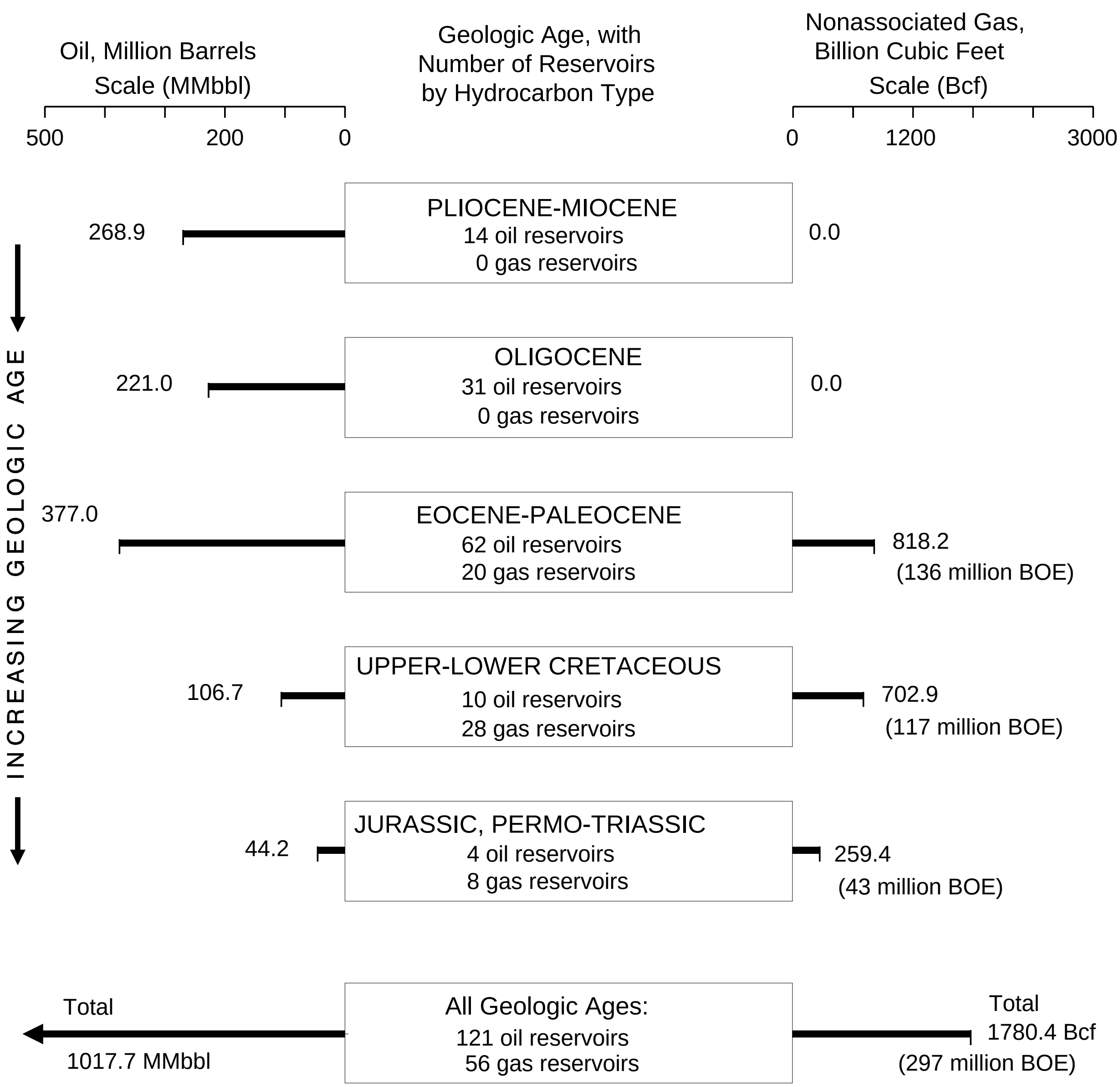
Source: Appendix A.

Figure 6. Comparison of Oil Reservoir Depths, by Structural Area and Geologic Age, Fergana Basin (through 1987)



Note: Wide depth ranges for reservoirs within same geologic age shown.
Source: Appendix A.

Figure 7. Stratigraphic Distribution for Ultimate Recovery of Discovered Oil and Gas, Fergana Basin (through 1987)



Note: Bar scales and units for oil and gas are set in order to compare barrels oil equivalent (BOE) at an approximate conversion of 1 barrel oil equals 6000 cubic feet gas. Totals may not equal sum of components due to independent rounding.

Source: Appendix A.

the geologic ages indicated, the older oil reservoirs are not always the deeper for depth ranges or average depths. On the flanks of intermontane basins, older sedimentary formations near the basin edges are typically at shallower depths than younger, downdip formations deposited toward the basin's center. Another notable item is the range of oil reservoir depths (vertical brackets) within various geologic ages. These wide depth ranges persist for each of the structural areas, even in the central basin graben. The usual basin geometry, with generally down-to-the-basin formational dips and faulted flanks, contributes to wide depth ranges for reservoirs identified within the same geologic age group. The most obvious difference of reservoir depths, for structural areas, is between the south flank (southwest of Fergana) and the central basin graben. For all the geologic age groups shown, the shallowest oil reservoirs are generally in the structural area of the south flank (southwest of Fergana), as compared to the deepest oil reservoirs in the structural area of the central basin graben.

Figure 7 illustrates the basin-level stratigraphic distribution of discovered oil and nonassociated gas. Oil and gas reservoirs are separated into five geologic age groups and the associated numbers of these reservoirs are shown. As in **Figures 4 and 5,** scales and units for the heavy horizontal bars allow direct comparison of BOE for oil and nonassociated gas. Of all the geologic age groups shown, Eocene-Paleocene reservoirs contained more ultimate recoverable oil and nonassociated gas. More Eocene-Paleocene oil reservoirs (62) were discovered, with 37 percent of the basin's total ultimate recoverable oil. Eocene-Paleocene gas reservoirs (20) account for 46 percent of the basin's total ultimate recoverable nonassociated gas. **Figure 7** also shows that the bulk of the basin's ultimate recoverable oil has been discovered in Tertiary-age reservoirs (85 percent in Pliocene-Miocene, Oligocene, and Eocene-Paleocene). Similarly, 88 percent of the oil reservoirs are of Tertiary age.

There is a sub-parallel correlation between the number of reservoirs in various groups and the amount of discovered oil and gas. The totals of reservoir ultimate recoveries roughly follow the numbers of reservoirs being totaled for some group. As noted in a following report section on field size distributions, most oil and gas reservoirs in this basin have a relatively narrow range for estimated field sizes. Thus, there will be correlation between the number of reservoirs being aggregated for a group and the total amount of estimated recoverable oil and gas. Part of the reason for this correlation may be geologic; some is likely a function of the estimated reservoir parameters and of the estimation process.

Other commentary can be made from the distributions illustrated in **Figures 4-7.** One of the most obvious is that by the end of 1987, most oil reservoirs and most of the basin's discovered oil were found in Tertiary-age formations at depths less than 8,000 feet on the basin's south flank. In the past, oil and gas exploration and development in a basin typically start on the basin's flanks and spread to more difficult prospects. Notwithstanding the potential of the central basin graben, the south basin flank may contain smaller but less expensive prospects for exploration, and particularly for development enhancements. This potential exists, although the south basin flank is in a mature stage of exploration.

Discovery History

Data were not obtained to analyze the history of exploratory well drilling in the Fergana basin. Exploration intensity across time is unknown, but can be inferred from the discovery history (**Table 2**). A **question-mark symbol (?)** follows field discovery years for those years inferred, rather than reported. The discovery history relies on estimates of recoverable oil and gas related to a field's year of discovery. For example, amounts estimated for any new reservoir discoveries in a field are related back to the year of the original discovery in the field.

Table 2 presents a history of field discoveries from 1901 at the Maylisay field, through 1987(?) at the Bedresay field. Field sizes represent total ultimate recoveries for a field's reservoirs in categories of oil, associated-dissolved gas, and nonassociated gas. This tabulation indicates sporadic oil exploration results with a broad primary peak during the 1943-1957 period. Discovered during this period were the two large field complexes of Maylisu IV-Izbaskent East (Kyrgyzstan), and Sharikan-Khodzhiabad (Uzbekistan). With the exception of additional discoveries in the Mingbulak field, declining results for oil exploration are evident after 1978, when the Tergachi field was found.

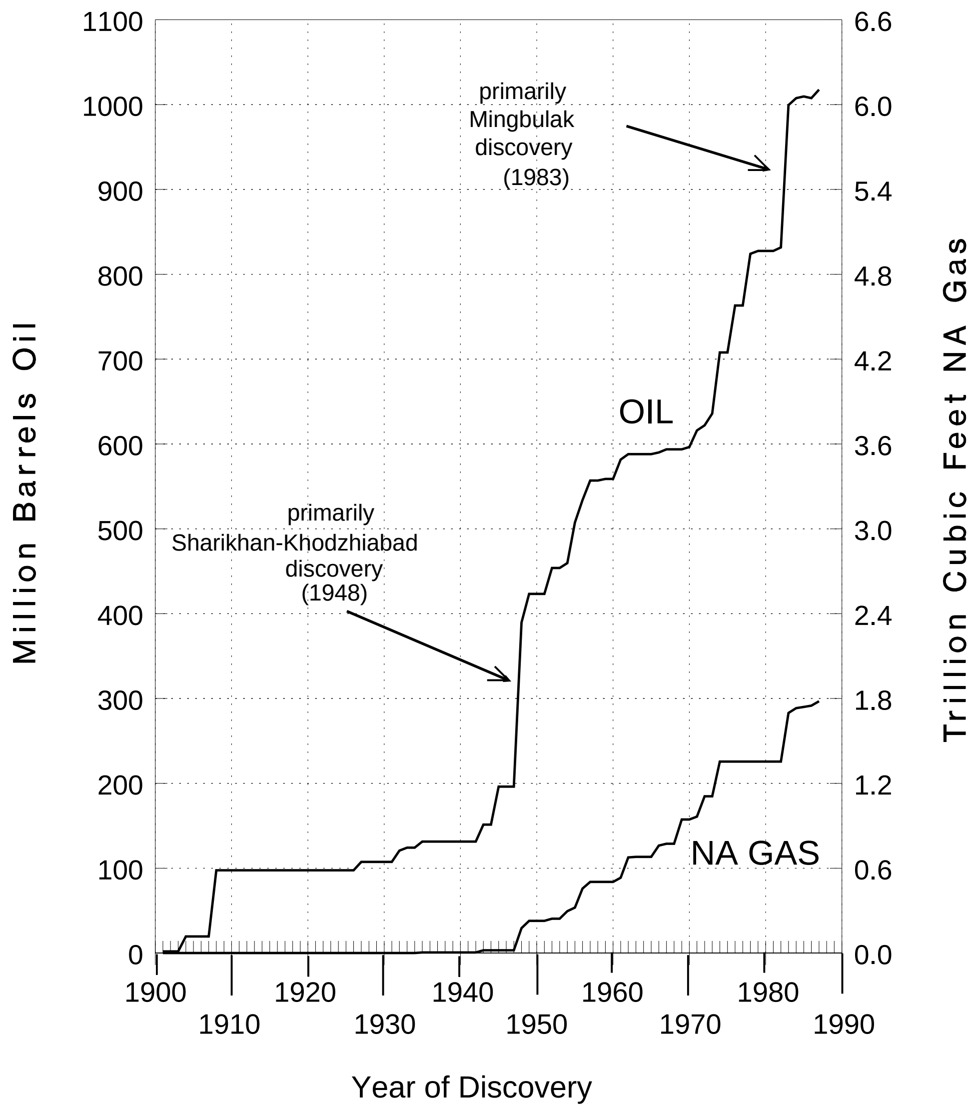
Table 2. Field-Size Distribution by Year of Discovery, in Terms of Ultimate Recovery, Fergana Basin (through 1987)

Year of Discovery	Field Name	Oil (MMbbl)	Associated-Dissolved Gas (Bcf)	Non-associated Gas (Bcf)	Total Natural Gas (Bcf)	Total Barrels Oil Equivalent (MMbbl)
1901	Maylisay	1.943	0.360	0.000	0.360	2.003
1904	Chaur-Yarkutan-Chimion	17.581	1.448	0.000	1.448	17.822
1908	Kim (Sel'rokho)	77.928	18.140	0.000	18.140	80.951
1927	Shorsu IV	9.959	1.881	0.000	1.881	10.273
1932	Changyrtash	13.292	4.272	0.000	4.272	14.004
1933	Nefteabad	3.536	0.725	0.000	0.725	3.657
1935	Andizhan	7.163	3.314	4.435	7.749	8.454
1943	Palvantash	20.008	0.967	14.906	15.873	22.654
1945	Alamyshik, Yuzh.(S)	44.824	9.441	0.000	9.441	46.397
1948	Maylisu IV-Izbaskent, Vost. (E)	68.865	21.284	150.925	172.209	97.566
1948	Sharikhan-Khodzhiabad	124.403	61.636	5.622	67.258	135.613
1949	Chongara-Gal'cha	33.841	34.993	51.748	86.741	48.298
1952	Boston	30.525	6.871	15.288	22.159	34.218
1954	Avval', Vost. (E)	2.197	0.419	0.000	0.419	2.266
1954	Rishtan, Sever. (N)	3.575	1.023	52.918	53.941	12.565
1955	Avval'	6.505	1.450	0.000	1.450	6.747
1955	Palvantash, Zap. (W)	41.354	6.465	0.000	6.465	42.431
1955	Sarykamysh	0.000	0.000	25.829	25.829	4.305
1956	Khodzhaosman	0.823	0.221	0.000	0.221	0.860
1956	Sokh, Sever. (N)	25.581	6.813	134.486	141.299	49.131
1957	Khankyz	17.356	0.851	40.898	41.749	24.314
1957	Khartum	5.641	3.811	5.448	9.259	7.184
1959	Namangan	1.857	1.559	0.000	1.559	2.117
1961	Ravat	22.798	22.003	29.480	51.484	31.378
1962	Maylisu III	6.443	3.714	144.469	148.183	31.140
1963	Sarytok	0.000	0.000	3.672	3.672	0.612
1966	Kanibadam	1.977	0.852	38.749	39.601	8.577
1966	Kyzyl-Alma	0.000	0.000	40.645	40.645	6.774
1967	Ayritan	3.692	0.932	13.039	13.972	6.021
1969	Suzak	0.000	0.000	171.913	171.913	28.652
1970	Kanabadam, Sever. (N)	2.695	1.356	0.000	1.356	2.921
1971	Varyk	19.612	12.430	20.498	32.928	25.100
1972	Izbaskent	5.882	2.198	143.332	145.530	30.137
1973	Alamyshik, Sever. (N)	10.432	4.861	0.000	4.861	11.243
1973	Shorbulak	3.537	2.936	0.000	2.936	4.027
1974	Karagachi-Tamchi	53.538	33.614	0.000	33.614	59.141
1974	Niyazbek-Karakchikum	18.550	10.290	245.824	256.113	61.236
1976	Beshkent-Togap	7.808	0.764	0.000	0.764	7.936
1976	Chigirchik	27.554	1.996	0.000	1.996	27.886
1976	Gumkhana	19.933	21.324	0.000	21.324	23.487
1978	Madaniyat	16.000	7.030	0.000	7.030	17.171
1978	Tergachi	39.410	22.786	0.000	22.786	43.207
1978	Varyk II	5.440	3.760	0.000	3.760	6.067
1979	Achisu	3.452	1.473	0.000	1.473	3.697
1982?	Obi-Shifo	4.185	0.804	0.000	0.804	4.318
1983	Mingbulak	164.869	230.098	343.852	573.950	260.527
1983?	Tasravet	2.865	0.810	0.000	0.810	3.000
1984	Khartum, Vost. (E)	8.227	4.193	33.625	37.818	14.530
1985?	Aksaray	0.000	0.000	8.752	8.752	1.459
1985?	Makhram	1.911	0.906	0.000	0.906	2.062
1986?	Kassansay	8.177	4.542	0.000	4.542	8.934
1986?	Shorsu VI	0.000	0.000	8.973	8.973	1.496
1987?	Bedresay	0.000	0.000	31.118	31.118	5.186
Totals:	**53 fields**	**1,017.743**	**583.620**	**1,780.444**	**2,364.065**	**1,411.754**

Notes: MMbbl = million U.S. barrels oil. Bcf = billion cubic feet gas. Ultimate recoveries are represented by the products of estimated original quantities in place and their respective estimated recovery efficiencies. "Reserves" are considered nearest to the U.S. reserve categories of Proved plus Probable, which are roughly equivalent to the former Soviet Union categories of A + B + C_1. Based on approximate heat contents for barrels oil equivalent (BOE), 6,000 cubic feet gas roughly equals 1 barrel oil. As surmised from the Uzbek presentation of August 25, 1993, and from Petroconsultants, at least 7 additional fields exist and probably were discovered after 1987. Question-marks (?) by field discovery years indicate inferred years, rather than reported years. Totals may not equal sum of components due to independent rounding.

Source: Energy Information Administration, Office of Oil and Gas.

Figure 8. Cumulative Discovery of Ultimate Recoverable Oil and Nonassociated (NA) Gas, Fergana Basin (through 1987)



Note: Vertical scales and units are set in order to compare barrels oil equivalent (BOE) at an approximate conversion of 1 barrel oil equals 6000 cubic feet gas. Thus, 1.8 trillion cubic feet NA gas is 300 million BOE, and the two plots compare as BOEs, across the graph.

Source: Table 2 and Appendix A.

Figure 8 displays plots of cumulative oil and nonassociated gas discoveries, using data shown in **Table 2**. The left-hand vertical scale and plot of **Figure 8** are for oil; the right-hand for nonassociated gas. The scales and their units are set so that plots of oil and nonassociated gas can be directly compared on the same graph as million barrels oil equivalent (BOE). The plotted values for nonassociated gas can be read as trillion cubic feet on the graph's right-hand vertical scale or million BOE on the left-hand vertical scale. For these data plots, ultimate recoveries from each of that field's oil and gas reservoirs are assigned to the field's discovery year. Thus, quantities from any gas reservoir in an oil field are incorporated in the **Figure 8** plot of cumulative discoveries of nonassociated gas. **Figure 8** shows periods of exploration activity/success (steeper curve slopes) and periods less successful or less active (more gradual curve slopes). The effects of large oil field discoveries, for example, Sharikan-Khodzhiabad and Mingbulak, are noted on the graph. The discovery of such exceptional fields boost an area's ultimate recovery, as indicated by the plots in **Figure 8** (including the sharp increase of discovered gas in 1983, for Mingbulak). Oil exploratory success in the Fergana basin became more moderate with time, after successes in the early-year period (1901-1957). Exceptions are a 1974-1978 secondary oil discovery peak and oil and gas discoveries in the Mingbulak field.

The history of nonassociated gas reservoir discoveries in **Table 2** is listed from year 1935 at the Andizhan field through 1987(?) at the Bedresay field. Sporadic discoveries of nonassociated gas are listed with the larger fields found from about 1948 through 1974, and later at the Mingbulak field (1983). The plot of cumulative discoveries of nonassociated gas in **Figure 8** shows a somewhat similar pattern to that for oil. Typically, for an oil and gas province, there is a general decline in the size of discoveries with time. However, neither of the **Figure 8** plots for oil nor nonassociated gas indicate that important discoveries in the Fergana basin are ending. Rather, the somewhat erratic discovery history and potential for more targets in the central and deeper parts of the basin both point to a potential for significant new discoveries. This potential will likely be determined by the capability to target, drill, and complete relatively deep wells.

Distributions of Field Size and Oil Reservoir Size

Oil and gas field sizes, in terms of ultimate recovery, are listed in **Table 3**. As a reminder, ultimate recovery is here represented to be cumulative production plus Proved and Probable reserves at the end of 1987. **Table 3** separates the numbers, types, and sizes of fields into the four basin structural areas. Of the four areas, the two having the largest average estimated oil field sizes are the central basin graben and the south basin flank, northeast of Fergana. The central basin graben has an average oil field size of 25.2 million barrels (3.4 million metric tons at an average API gravity of 34.5 degrees). The south basin flank, northeast of Fergana, has an average oil field size of 27.9 million barrels (3.7 million metric tons at an average API gravity of 36.6 degrees). Both of these high average oil field sizes are mostly influenced by the Mingbulak field, in the central basin graben, and the Sherikhan-Khodzhiabad field combination in the south basin flank, northeast of Fergana. This part of the south basin flank also has the highest oil reservoir-to-field ratio of 3.6, indicating the multiple pay zone nature of most of its 12 oil fields.

As noted in **Tables 2 and 3,** the smallest oil field size estimated for the Fergana basin is about 1 million barrels (Khodzhaosman field, with 0.823 million barrels or 0.108 million metric tons at 40.0 degrees API gravity). It is assumed that smaller field accumulations of recoverable oil exist, but are not developed, or not reported, or have been combined with other field accumulations for reporting.

The **Table 3** listings for gas fields provide ancillary data to the oil field listings. By the definitions used for this assessment, all reservoirs in a gas field must contain only nonassociated gas or gas condensate, not oil. Thus, only seven gas fields are counted in the Fergana basin, and the average gas field size for these is 41.6 billion cubic feet (1.2 billion cubic meters). The largest gas field in terms of ultimate recovery is Suzak, located in the south basin flank, northeast of Fergana (171.9 billion cubic feet or 4.9 billion cubic meters).

Figure 9 provides a broad illustration of the basin's discovery history, separated into two historical periods, i.e., before and after the end of year 1957. This figure

Table 3. Field-Size Distribution and Number of Fields, by Structural Area, Fergana Basin (through 1987)

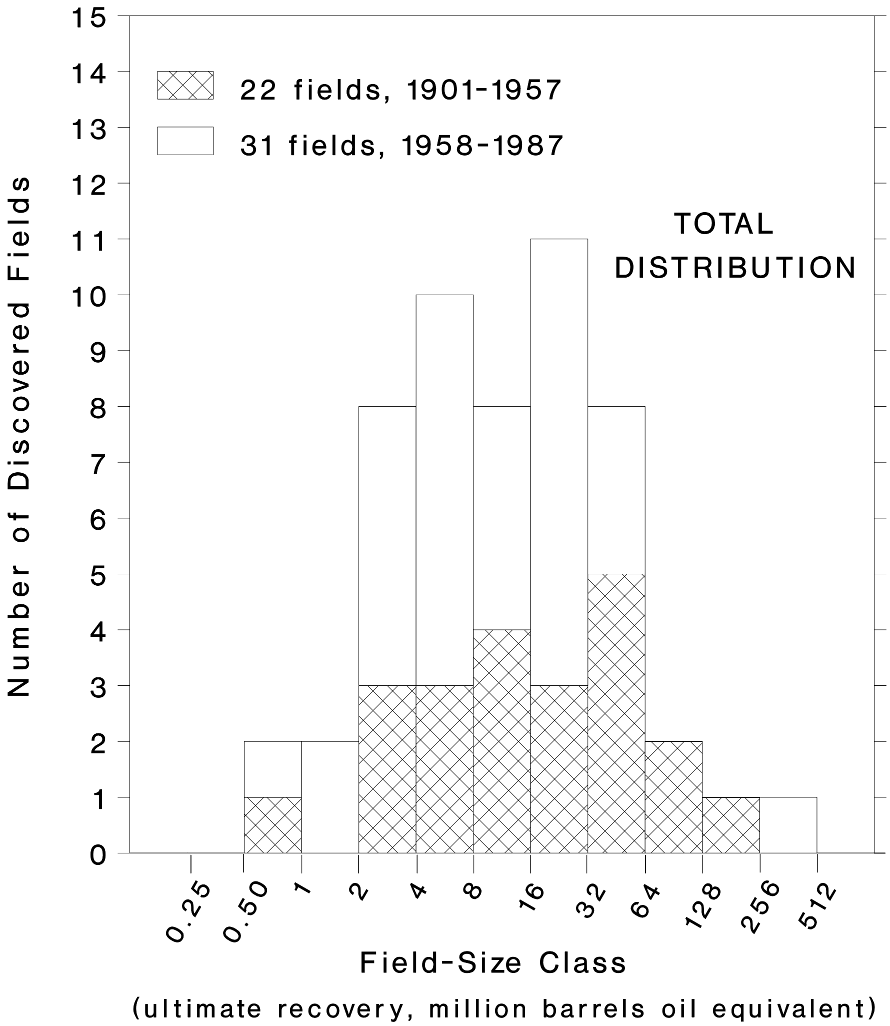
Categories	North Basin Flank	South Basin Flank: Northwest of Fergana	South Basin Flank: Southwest of Fergana	Central Basin Graben	Entire Fergana Basin
Average Oil Field Size (million barrels)	17.0	27.9	18.0	25.2	22.1
Oil Field Size Range (million barrels)	2-69	1-124	2-78	2-165	1-165
Number of Oil Fields[a]	8	12	15	11	46
Number of Oil Reservoirs	20	43	32	26	121
Oil Reservoir/Field Ratio	2.5	3.6	2.1	2.4	2.6
Average Nonassociated Gas Field Size (billion cubic feet)	35.9	171.9 (1 field)	11.8	(no fields)	41.6
Nonassociated Gas Field Size Range (billion cubic feet)	31-151	171.9 (1 field)	4-134	(no fields)	4-172
Number of Nonassociated Gas Fields[b]	2	1	4	none	7
Number of Nonassociated[b] Gas Reservoirs	18	10	19	9	56

[a]Oil fields are so designated if only one of their reservoirs in a multiple stack contains oil; oil fields can contain nonassociated gas reservoirs.

[b]Gas fields are so designated if all of their reservoirs in a multiple stack contain only gas or gas condensate. A gas reservoir/field ratio is not meaningful and is not included primarily because various nonassociated gas reservoirs are contained in oil fields.

Source: Appendix A.

Figure 9. Distribution of Discovered Fields by Size Class (ultimate recovery of barrels oil equivalent), Separated into Periods 1901-1957 and 1958-1987, Fergana Basin



Note: Mingbulak field, with 261 million barrels oil equivalent (BOE), is the one large field shown in the 256-512 million BOE range.

Source: Appendix A

trate a general discovery history for what are a limited number of fields with a limited range of estimated BOE sizes. The following list of statements summarizes the BOE field size distribution as shown by **Figure 9's** frequency-of-occurrence graph and as derived from data in **Table 2.**

- The first 22 field discoveries (1901-1957) have a distribution shifted slightly toward the larger size fields, with a mode at field-size class 32-64 million BOE (4.328-8.657 million metric tons oil equivalent, at 7.393 barrels per metric ton).

- Only 3 of these 22 initially discovered fields were discovered before year 1927; thus, initial effective exploration activity actually occurred during the 31-year period of 1927 through 1957.

- When the 31 field discoveries are added for the next 30-year period of 1958-1987, the total distribution of discovered fields becomes somewhat more symmetrical, with bimodal peaks between 4 and 32 million BOE (0.541-4.328 million metric tons oil equivalent).

- While the data can be sorted, grouped, and graphed differently, these distributions, nevertheless, show a shift toward smaller field-size discoveries as exploration has proceeded in this basin. These observations are not unique for an oil and gas province progressing toward a mature stage of exploration. However, with the apparent limited areal and depth extent of exploratory drilling, this province has probably not reached exploration maturity.

- Typically, a similar histogram of field-size distribution after the next 30 years of exploration (post 1987), would show a left-hand shift more toward the smaller size fields. That is, unless substantial new plays (such as deeper prospects) result in the discovery of numerous new fields each larger than about 16 million BOE (2.164 million metric tons oil equivalent), the mode of this distribution would shift left. Stated another way, if only historical exploration data are considered, one would infer that future field discoveries will most often be smaller than about 16 million BOE each (roughly 2 million metric tons oil equivalent).

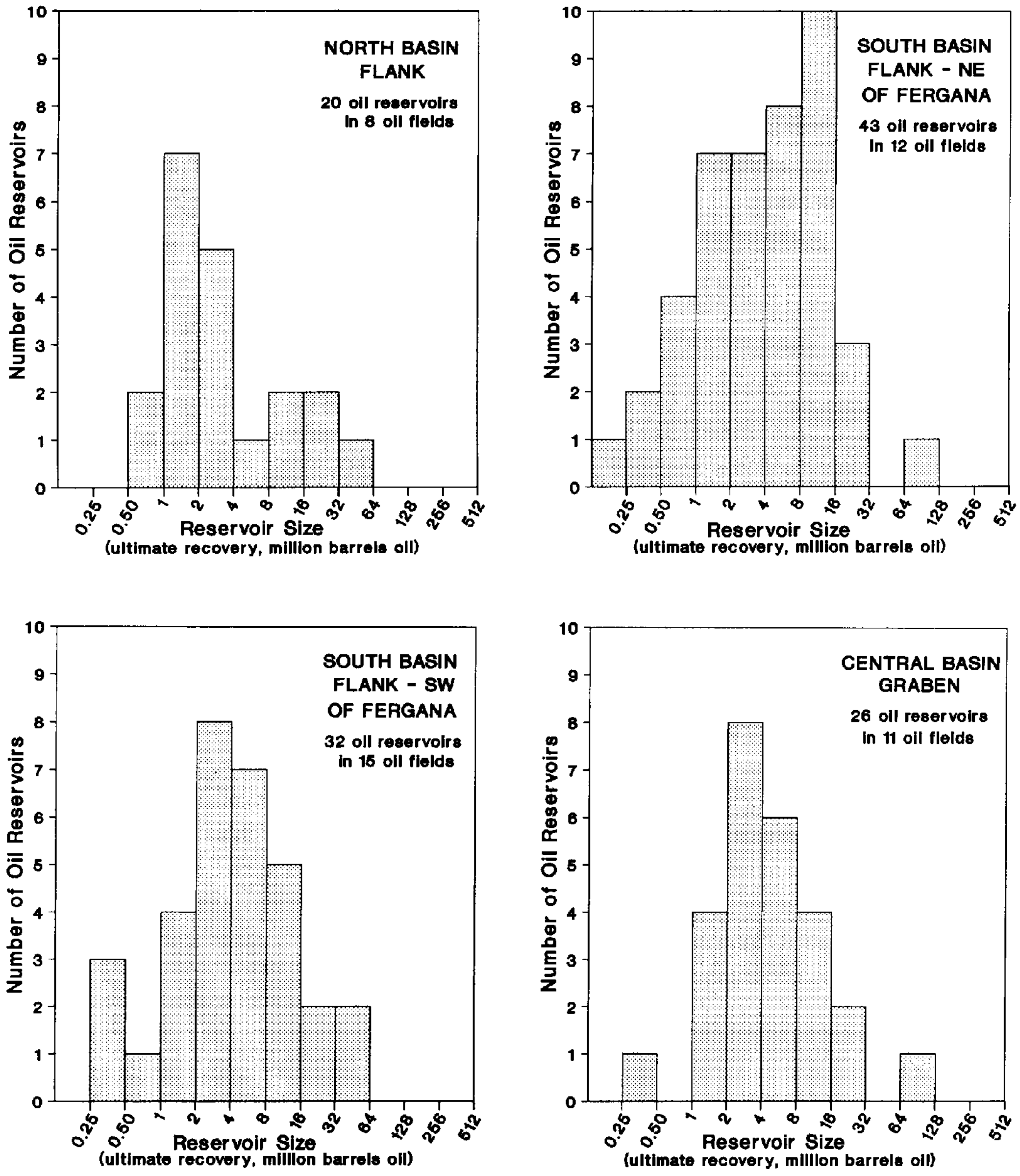
The potential of the central basin graben remains as the primary assessment question. Can significant commercial oil and gas be recovered from the Mingbulak field, and if so, how many more Mingbulak-type oil and gas fields are there to be discovered in the central basin graben?

Figure 10 illustrates histogram comparisons of oil reservoir size for each of the four basin structural areas. For each structural area, the number of occurrences are graphed for oil reservoirs in ultimate recovery size classes. These size classes, with doubling values, are the same as used in **Figure 9,** but are only for oil and do not include BOE for natural gas. The number of oil reservoirs and oil fields are also shown for each structural area histogram of **Figure 10.** The most frequently discovered oil reservoir size in the north basin flank is in the modal range of 1 to 2 million barrels (0.136-0.271 million metric tons at 34.3 degrees API). For the south basin flank, northeast of Fergana, most oil reservoir discoveries have been in the size class of 8 to 16 million barrels (1.071-2.141 million metric tons at 36.6 degrees API). Smaller oil reservoirs have more frequently been discovered in the south basin flank, southwest of Fergana, with a modal size class of 2 to 4 million barrels (0.272-0.544 million metric tons at 33.9 degrees API). Likewise, the modal range of 2 to 4 million barrels is shown for discovered oil reservoirs in the central basin graben (0.271-0.542 million barrels at 34.5 degrees API). If one views only **Figure 10,** one can surmise that of the four basin structural areas, the south basin flank, northeast of Fergana, has offered oil discovery advantages. This structural area has the largest oil reservoirs occurring more often, with a modal range of 8 to 16 million barrels ultimate recovery. Through 1987, this structural area also had more oil reservoirs discovered (43 reservoirs in 12 fields) than any other of the four basin structural areas. Comparisons of these types of historical oil discovery data can assist in considering future basin exploration.

Potential of Mingbulak Area

Estimates of the potential for oil recovery in the Fergana basin were substantially increased after March 2, 1992, when Mingbulak's well number 5 blew out and caught fire. Uncontrolled flows from this well continued for about 2 months, at estimated rates reported from about 35,000 to 150,000 barrels of oil per day (4,869 to 20,869 metric tons per day at a reported oil density of 30.2 degrees API gravity). These ungauged rates of flow were roughly estimated from varied observations of surface accumulations. In any event, over

Figure 10. Comparison of Oil Reservoir Size Distributions, by Structural Area, Fergana Basin (through 1987)



Note: Average oil reservoir ultimate recovery for the entire basin is 8.411 million barrels.
Source: Appendix A.

2 million barrels of oil (278,252 metric tons) were diked by emergency earthworks before the hole naturally stopped flowing. Apparently, flow ceased because a bridge formed in the hole; other explanations are also possible. The blowout reportedly came from a thick (125 feet, or 38 meters of net pay) Miocene sandstone reservoir at a depth of about 17,182 feet (5,237 meters).

Previously, Glumakov and others (1988, as listed in the *Data Sources* section) reported commercial oil in a deeper Paleocene reservoir (zone IX) at Mingbulak. On August 25, 1993, 5 oil reservoirs were reported for Mingbulak's Pliocene-Miocene (Neogene) section and 3 additional oil reservoirs for the Oligocene-Paleocene (Paleogene) section. At this time, estimates of recoverable oil and gas are made here for only 3 oil reservoirs and 1 gas condensate reservoir, all of Tertiary (Neogene-Paleogene) age. These estimates are under the Proved plus Probable reserves categories. Besides well number 5, the 3 previous Mingbulak wells are reported to have experienced problems with high pressures. In Mingbulak well number 3, the first Miocene (Neogene) oil reservoir was found at a depth of 17,208 feet or 5,245 meters. This well was flow tested at about 5,749 barrels of oil per day (using an oil density of 30.2 degrees API, or 800 metric tons per day with an estimated specific gravity of 0.8752 grams per milliliter). Other flow tests in well number 3 ranged down in the Tertiary (Neogene-Paleogene) section to a depth of about 19,393 feet (5,911 meters). Lesser oil flows were tested at interval tops of about 18,340 and 19,226 feet deep (5,590 and 5,860 meters, respectively). Those lower oil tests are reported to range up to about 494 barrels of oil per day with an oil gravity of 42 degrees API (64 metric tons per day with an estimated specific gravity of 0.815 grams per milliter). Gas and gas condensate were flow tested at an interval top of about 19,354 feet (5,899 meters) deep, from Paleocene zone IX. The zone IX flow test in well number 3 was reported to range up to about 7 million cubic feet of gas per day (200 thousand cubic meters gas, and 55 metric tons of condensate per day). Oil and gas have yet to be successfully produced from the Mingbulak field.

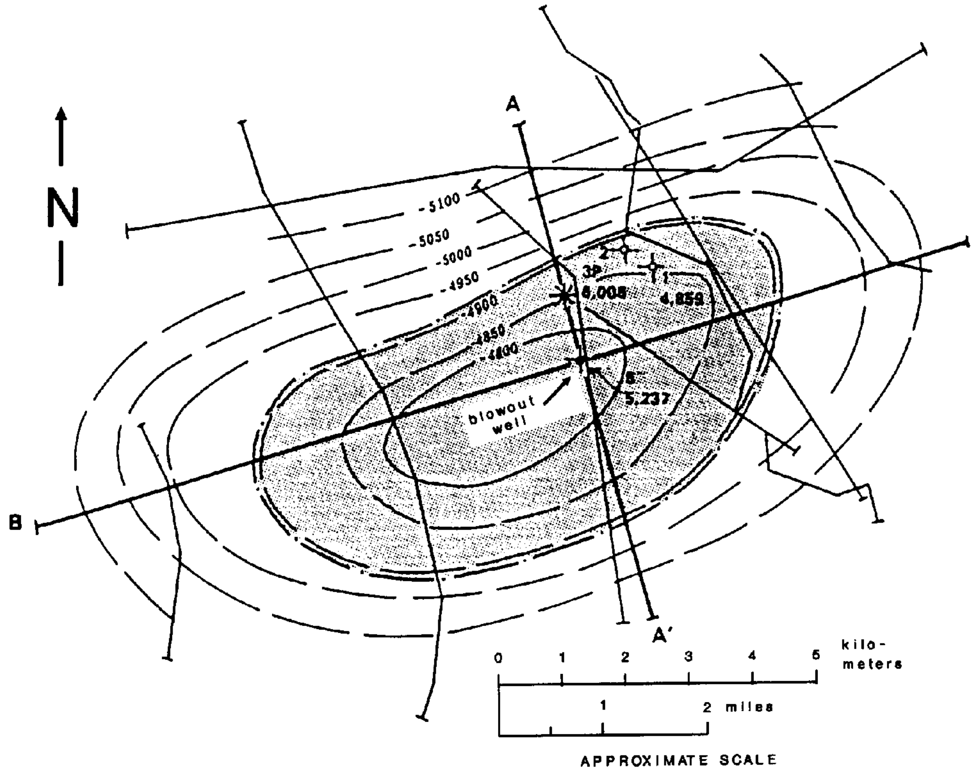
Pressures variously reported for Mingbulak reservoirs in well number 3 range from 15,597 pounds per square inch (108 million pascals) at 19,354 feet (5,899 meters) deep to 18,375 pounds per square inch (127 million pascals) at about 17,208 feet (5,245 meters) deep. (This unexplained reduction in pressure with increasing depth may be related to data inaccuracies). Pressure gradients for such pressures respectively range from about 0.806 to 1.068 pounds per square inch per foot depth; these are near to twice "normal" pressure gradients (0.433 pounds per square inch per foot depth). Other overpressured reservoirs in the Fergana basin are at Gumkhana field, south-southeast across the valley from Mingbulak. At Gumkhana, pressures of about 10,290 pounds per square inch (71 million pascals) are reported at depths of about 11,811 feet (3,600 meters). With the severe overpressure situation at Mingbulak, one should consider probable closing effects on the permeability system when reservoir pressures are reduced by production.

For the Fergana basin, relatively high gas-oil ratios were estimated for both the Mingbulak and Gumkhana fields (at roughly 1,300 cubic feet gas per barrel oil). Selection of lower values than those used in this assessment, for gas-oil ratios and therefore, for lower oil formation volume factors, would readily cause oil and gas volumetric estimates to change. If so applied to Mingbulak oil reservoirs, for example, estimates of recoverable oil would increase and estimates of recoverable, associated-dissolved gas would decrease.

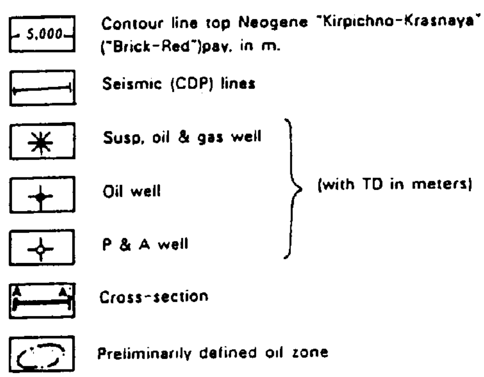
Obviously, special well drilling and completion equipment, fluids, and techniques are needed to exploit the Mingbulak reservoirs; this would be expensive work. Well number 5 is reported to have taken about 2 years to drill. As example contributors to "slow" drilling, it is understood that: (a) drilling of a well in the Fergana basin does not proceed continuously; and (b) large-diameter drilling bits at Mingbulak were used down to near the total depths for wells number 3 and 5. Four additional Mingbulak wells, with their locations generally aligned east-west, were reported as having drilling underway in September 1993.

Mingbulak's structure is interpreted as a fairly broad anticlinal feature, with about 19,768 acres (80 square kilometers) of what is considered to be seismic, structural closure. **Figure 11** is a subsurface contour map of the Mingbulak structure which also indicates the locations of wells, seismic profile lines, and cross-sections. This structure contour map (unknown origin, fall of 1993) was derived from interpretations of seismic data and downhole data from the few wells. At three

Figure 11. Structural Contour Map Atop the Brick-Red Sandstone, Miocene Massaget Formation, Mingbulak Field, Fergana Basin



MINGBULAK FIELD (Fergana Basin, Uzbekistan) Structure Map – Top Neogene "Kirpichno-Krasnaya" Pay



Note: Contours in meters apparently represent depths below some horizon near ground level, rather than below mean sea level. Blowout well number 5, at the cross-section intersection, is shown to be highest on the structure. Legend is reprinted from source.

Source: Slightly modified from subsection 5.8 of unpublished compilation by Talley (1993). Originator of figure is unknown.

well locations, meter depths below the surface are given for the mapped Miocene sandstone (the blowout reservoir). Meter depths below sea level are given for contour lines defining the top of this Miocene sandstone. Relief of this structural closure was separately reported to be about 1,148 feet (350 meters). This anticlinal feature is expected to be faulted and may have separate fault-block reservoirs. For Mingbulak's Tertiary reservoirs in this assessment (3 oil, 1 gas condensate), about 8,000 acres were estimated as productive. This area was based on structural closure and the lowest known occurrence of oil. This feature has "stacked" (multi-horizon) reservoirs in the Tertiary section, potentially in the underlying Cretaceous section, and possibly in the Jurassic section. At these depths (and temperatures), any Cretaceous or Jurassic reservoirs at Mingbulak field are expected to be gaseous. One contact at the Uzbek conference in August 1993, indicated that the aggregate net pay of stacked Tertiary reservoirs in the Mingbulak structure was about 984 feet (300 meters). Also revealed at this conference was the interesting seismic identification of 22 other deep traps in the central basin graben that are similar to Mingbulak. Structural closure on these features, which are probably anticlinal, is from about 9,884 to 24,711 acres (40 to 100 square kilometers). Three of these seismic features are reported as being drilled in September 1993. Previous drilling attempts to reach these structures have not been successful.

As aptly noted by Heafford and Lichtman of Jebco Seismic, in the August 9, 1993, issue of the *Oil and Gas Journal*, "the oil window lies over a wide depth range." The article lists 25 to 30 degrees Celsius per kilometer of depth as the geothermal gradient for Uzbekistan, as applied to the Fergana basin. This rate of temperature change equates to about 1.37 to 1.65 degrees Fahrenheit per 100 feet of depth, which are higher than those usually found in the United States. As shown in Appendix C, **Figure C1**, an equation was derived for estimating subsurface temperatures in the Fergana basin. This general temperature gradient was determined to be 1.21 degrees Fahrenheit per 100 feet of depth, with an average surface temperature of about 68 degrees Fahrenheit (22.05 degrees Celsius per kilometer, plus 20 degrees Celsius). A subsurface temperature for Mingbulak well number 3 was measured
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93 degrees Fahrenheit at 17,667 feet deep (145 degrees Celsius at 5,385 meters). For comparison, application of the general **Figure C1** equation to this Mingbulak well depth would result in an estimate of about 282 degrees Fahrenheit (139 degrees Celsius). Other estimated and measured temperatures for oil reservoirs at Mingbulak are from about 287 to 320 degrees Fahrenheit. At about 300 degrees Fahrenheit, liquid hydrocarbons start to decompose; crude oil blown from Mingbulak well number 5 is indicated to be waxy. In any event, deep crude oil exists at the Mingbulak field, and its potential extends to some other deep sections of the basin.

Reservoir Comparisons

Comparisons of Reservoir Parameters by Structural Area

Table 4 presents a complex, but insightful, summary tabulation from some of the reservoir-level files. Other than for the Mingbulak field, listed average and range values for the rest of the areas are fairly common. That is, unusual subsurface conditions are not obvious by the data arrangement presented in **Table 4**. For example, the difference of average reservoir depths is understandable, from reservoirs on the south basin flank (southwest of Fergana, at 3,241 feet or 988 meters), to 12,216 feet or 3,723 meters in the central graben/western basin, to 18,532 feet (5,649 meters) average depth at Mingbulak.

Area-to-area similarities are noted in **Table 4** for "small" average reservoir areas, "thick" average net pays, "high" average porosities, "low" gas-oil ratios, and the fairly narrow ranges of estimated water saturations and oil gravity. Again, various similarities of estimates between the structural areas of **Table 4** may be a function of data quality. Any analysis depends upon the accuracy of its data. While not all of these data are claimed to be accurate, the analysis method was commonly consistent. Notable exceptions are the Mingbulak and Gumkhana fields, because more direct data were available for these and some other fields.

Table 4. Comparisons of Reservoir Parameters by Structural Area, Fergana Basin (through 1987)

Summary Parameters	North Basin Flank	South Basin Flank		Central Basin Graben[a]	Mingbulak Field	Entire Fergana Basin
		Northeast of Fergana	Southwest of Fergana			
Number of Oil Reservoirs and Nonassociated Gas Reservoirs	20 oil 18 gas	43 oil 10 gas	32 oil 19 gas	23 oil 8 gas	3 oil 1 gas	121 oil 56 gas
Number of Sandstone (ss) Reservoirs and Carbonate (cb) Reservoirs	31 ss 7 cb	35 ss 18 cb	32 ss 19 cb	21 ss 10 cb	3 ss 1 cb	122 ss 55 cb
Average Reservoir Depth (feet)	6,529	4,301	3,241	12,216	18,532	6,182
Average Oil Reservoir Ultimate Recovery[b] (million barrels)	6.806	7.773	8.442	4.886	54.956	8.411
Average Nonassociated Gas Reservoir Ultimate Recovery[d] (billion cubic feet)	28.360	25.124	17.911	41.819	[c]343.852	31.794
Average Reservoir Area (acres)	2,485	955	2,271	2,150	8,006	2,031
Average Reservoir Net Pay (feet)	25	37	27	24	62	30
Average Reservoir Porosity (percent)	13.4	16.0	18.7	16.0	18.0	16.2
Reservoir Water Saturation Range (percent)	20 - 42	22 - 48	23 - 65	25 - 43	35	20 - 65
Average Oil Reservoir Initial Formation Volume Factor (barrels per stock tank barrel)	1.240	1.187	1.134	1.329	1.689	1.221
Average Oil Reservoir Gas-Oil Ratio (cubic feet gas per barrel oil)	458	343	243	633	1,483	419
Reservoir Oil Gravity Range (degrees API)	31 - 43	30 - 44	26 - 37	29 - 41	30-42	26 - 44
Average Reservoir Primary Oil Recovery Efficiency	23.0	24.3	17.2	20.3	16.0	21.2

[a]Central basin graben fields as identified by Glumakov, et al, 1988, excluding Mingbulak field. See Figure 3.
[b]Applied individual oil recovery efficiencies to estimated oil in place, reservoir-by-reservoir.
[c]Only 1 gas condensate reservoir represents the "average" value.
[d]Applied individual nonassociated gas recovery efficiencies to estimated nonassociated gas in place, reservoir-by-reservoir.
Source: Energy Information Administration, Office of Oil and Gas.

Table 5. Comparisons of Oil Reservoirs by Structural Area and Geologic Age, Fergana Basin (through 1987)

Selected Parameters	North Basin Flank	South Basin Flank: Northeast of Fergana	South Basin Flank: Southwest of Fergana	Central Basin Graben	Entire Basin (by Age)
PLIOCENE-MIOCENE AGE (youngest)					
Avg. Depth	7324 feet	1727 feet	no discovered oil reservoirs	15579 feet	5495 feet
Avg. Area	3540 acres	873 acres		4275 acres	1983 acres
Avg. Thickness	46 feet	48 feet		88 feet	56 feet
Avg. Ult. Recov.	30.8 MMbbl	8.5 MMbbl		43.7 MMbbl	19.2 MMbbl
Avg. Oil Gravity	33.5° API	35.9° API		32.7° API	34.9° API
Num. Reservoirs	2 ss, 0 cb	8 ss, 1 cb		3 ss, 0 cb	13 ss, 1 cb
OLIGOCENE AGE					
Avg. Depth	4522 feet	3913 feet	3256 feet	12363 feet	6275 feet
Avg. Area	4600 acres	1243 acres	2424 acres	2912 acres	2465 acres
Avg. Thickness	14 feet	29 feet	20 feet	20 feet	22 feet
Avg. Ult. Recov.	6.2 MMbbl	7.3 MMbbl	6.5 MMbbl	8.0 MMbbl	7.1 MMbbl
Avg. Oil Gravity	32.2° API	35.7° API	33.3° API	37.0° API	35.0° API
Num. Reservoirs	4 ss, 0 cb	10 ss, 0 cb	8 ss, 0 cb	9 ss, 0 cb	31 ss, 0 cb
EOCENE AGE					
Avg. Depth	6689 feet	3905 feet	2790 feet	12408 feet	5866 feet
Avg. Area	4317 acres	946 acres	3287 acres	2041 acres	2475 acres
Avg. Thickness	11 feet	33 feet	18 feet	21 feet	21 feet
Avg. Ult. Recov.	2.6 MMbbl	4.7 MMbbl	10.7 MMbbl	3.8 MMbbl	6.2 MMbbl
Avg. Oil Gravity	33.9° API	34.8° API	34.1° API	32.6° API	33.9° API
Num. Reservoirs	3 ss, 6 cb	2 ss, 12 cb	11 ss, 8 cb	5 ss, 7 cb	21 ss, 33 cb
PALEOCENE AGE					
Avg. Depth	6647 feet	no discovered oil reservoirs	2679 feet	15946 feet	7459 feet
Avg. Area	1908 acres		846 acres	5208 acres	2335 acres
Avg. Thickness	7 feet		25 feet	32 feet	20 feet
Avg. Ult. Recov.	1.5 MMbbl		2.4 MMbbl	14.5 MMbbl	5.1 MMbbl
Avg. Oil Gravity	33.0° API		33.0° API	37.6° API	34.1° API
Num. Reservoirs	3 ss, 0 cb		1 ss, 2 cb	1 ss, 1 cb	5 ss, 3 cb
PRE-TERTIARY AGE (oldest)					
Avg. Depth	4577 feet	6185 feet	3860 feet	no discovered oil reservoirs	5623 feet
Avg. Area	1124 acres	855 acres	1218 acres		945 acres
Avg. Thickness	38 feet	45 feet	54 feet		45 feet
Avg. Ult. Recov.	10.9 MMbbl	12.0 MMbbl	4.4 MMbbl		10.8 MMbbl
Avg. Oil Gravity	43.0° API	40.7° API	36.0° API		40.4° API
Num. Reservoirs	2 ss, 0 cb	10 ss, 0 cb	2 ss, 0 cb		14 ss, 0 cb

Note: Abbreviations are: Avg. = average; Ult. Recov. = ultimate recovery (of discovered oil); MMbbl = million U.S. barrels; API = American Petroleum Institute (degrees oil gravity); Num. = number; ss and cb = sandstone and carbonate (oil reservoirs).

Source: Appendix A.

Among other interesting items in **Table 4**, is the fairly narrow range of estimated average primary oil recovery efficiencies. This is from 17.2 to 24.3 percent.

Besides the Mingbulak field, it is noted that the western/central basin graben (Glumakov, et al, 1988) has the highest average of reservoir ultimate recoveries for nonassociated gas. This structural area also has the deepest average reservoir depth (12,216 feet or 3,723 meters, notwithstanding Mingbulak). Other comparisons can be made from summary data in **Table 4,** or from reservoir-level data in Appendix A or on the available diskette.

Comparisons of Oil Reservoirs by Structural Area and Age

Table 5 is a companion illustration to **Table 4's** listing of oil and gas reservoir parameters. **Table 5** presents a set of comparison information for oil reservoirs, only. **Table 5** provides a matrix of 6 selected reservoir/fluid parameters, identified with each of the 4 basin structural areas, and further separated into 5 geologic age groups. For example, at the top of each of the left-hand column cells, one can find the average oil reservoir depth for each of the geologic age groups shown, in the north basin flank. Continuing the example, 6,689 feet (2,039 meters) is the average depth of 3 sandstone and 6 carbonate Eocene oil reservoirs discovered in the north basin flank. Following, the average ultimate oil recovery for these 9 reservoirs is 2.6 million barrels (0.354 million tons) with an average density of 33.9 degrees API gravity, etc.

General comparisons can be made from the matrix information in **Table 5;** some obvious ones are listed below.

- The deepest oil reservoirs, of whatever geologic age group, are located in the central basin graben.
- Average estimated oil reservoir areas in the south basin flank, northeast of Fergana, are somewhat smaller than in other structural areas (855 to 1,243 acres, or 3.5 to 5.0 square kilometers).
- Paleocene-Eocene-Oligocene (Paleogene) oil reservoirs in the north basin flank have relatively thin average estimated thicknesses (net pays), from 7 to 14 feet (2-4 meters). Other cells in the matrix figure show thicker average estimated net pays, from 18 to 88 feet (5-27 meters).
- The 2 cells showing the highest average ultimate oil recovery are of Pliocene-Miocene age, in sandstone reservoirs of the north basin flank and central basin graben (30.8 and 43.7 million barrels, respectively, or 4.2 and 6.0 million metric tons). Other cells show lower average ultimate oil recoveries, in the range of 1.5 to 14.5 million barrels (0.2-1.9 million metric tons). These barrel-to-metric ton conversions are done with oil gravities shown in appropriate cells of **Table 5**.
- The average estimated oil gravity for reservoirs of Tertiary age (Paleocene through Pliocene) is similar, across the basin (33.2-37.6 degrees API). Of no surprise, oils from pre-Tertiary age reservoirs are generally less dense, with estimated averages of 36.0 to 43.0 degrees API, across the basin.
- Almost all of the Pliocene-Miocene oil reservoirs are sandstones. All Oligocene and pre-Tertiary oil reservoirs are sandstones. Carbonate lithologies dominate Eocene oil reservoirs across the basin.

As noted in the previous discussion of **Table 4,** other comparisons can be made, from reservoir-level data in Appendix A or from the available diskette.

Distributions of Discovered Oil and Gas by Republic Areas

After locations of the five Uzbek license blocks were announced, data on fields discovered through year 1987 were sorted for these areas. The aggregate area of these five blocks is about 6,221 square miles or 16,112 square kilometers **(Figure 2**). Available data do not provide accurate field locations or their relation to republic boundaries. Nevertheless, field locations were assigned to the republics of Uzbekistan, Tadzhikistan, and Kyrgyzstan, and further assigned to the Uzbek license blocks. Two field-combinations were estimated to cross the boundary between Uzbekistan and Kyrgyzstan (Chaur-Yarkutan-Chimion and Chongara-Gal'cha). One-half of the ultimate oil and gas recovery estimated for these field-combinations was simply assigned to each republic.

With these qualifications regarding field locations, **Table 6** was prepared to show republic and license block estimated areal distributions of oil, associated-dissolved gas, and nonassociated gas in the Fergana basin. The five Uzbek license blocks encompass over one-half (29 of 53) of Fergana basin oil and gas fields discovered through 1987. In terms of ultimate oil recovery, these Uzbek license blocks contain nearly one-half (48.3 percent) of Fergana basin oil discovered through 1987. Tadzhikistan has about 17 percent of the Fergana basin oil and gas fields and about 20 percent of the oil discovered through 1987. Kyrgyzstan has about 26 percent of the Fergana basin oil and gas fields and about 16 percent of the oil discovered through 1987. The Mingbulak field was not included with the five license blocks of Uzbekistan's August 1993 solicitation for tender offers. Kyrgyzstan is receptive to doing Fergana basin business with Western companies, and in 1995, may publically solicit competitive bids for blocks within the basin. Such Kyrgyz blocks could be on the northwest basin flank and/or the south basin flank **(Figure 2).**

A basic point of these statistics is that the borders of Uzbekistan do not encompass all oil and gas discovered in the Fergana basin **(Figure 2)**. Significant oil and gas have been discovered and are being produced in Tadzhikistan and Kyrgyzstan (over 35 percent of the discovered Fergana basin oil, in terms of ultimate recovery, through 1987). An additional observation is the potential of future large oil discoveries in the deep (below about 17,000 feet or 5.2 kilometers) Tertiary-age section of the central basin graben. This potential was signaled by the Mingbulak oil blowout. Previous analyses have made note of the deep-basin potential. While the 22 structures similar to Mingbulak have been identified by seismic exploration techniques, those potential structures (and reservoirs) await exploration by the drill. These 22 structures are thus not discoveries and most of them are believed to be smaller than the Mingbulak structure.

With an estimated 165 million barrels of ultimate oil recovery as Proved and Probable reserves, Mingbulak is the largest Fergana basin field and contains about 16 percent of the entire basin's oil discovered through 1987. As with other estimates of field discovery years, all of Mingbulak's reservoirs are assigned to the initial field discovery year (Mingbulak as 1983, when well number 3 was drilled). The Mingbulak's oil blowout occurred during March and April of 1992, at well number 5. Wells number 1 and number 2 are under-
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d to have not been drilled to their objectives. In September 1993, Mingbulak well numbers 4, 6, and 8 were being drilled as was number 222, a twin to blowout well number 5. The current well status is unknown, but it is doubtful that these new-well drilling objectives or successful well completions will have been accomplished by December 1994. Therefore, delineation drilling has yet to confirm Mingbulak's 165 million barrels of ultimate oil recovery estimated in this analysis.

Regarding the five blocks being offered by Uzbekistan in the Fergana basin, some simple comparisons can be made by reviewing **Figure 2 and Table 6**. Block 5 contains about 47 percent of oil discovered in the Uzbek offered areas, by the end of 1987. Block 5 is at the eastern end of the basin. Block 4, nearest to the western end of the basin, contains about 62 percent of nonassociated gas that had been discovered in the Uzbek offered areas, by the end of 1987. (Various reservoirs in known fields of Block 4 and in Tadzhikistan's fields at the western end of the basin tend to be deeper and more gas-prone than typical basin reservoirs.) Uzbek Blocks 2 and 3 cross the central basin and contain a variety of relatively shallow and deep structures. Some of the deep, central graben's 22 undrilled structures mentioned at Uzbekistan's offering, implied as similar to Mingbulak, likely occur in the subsurface of Blocks 1, 2, and 3 (**Figure 2**). It is unknown how many of such structures have been identified in the unoffered area surrounding Mingbulak. Block 1, with only 4 fields, had about 5 percent of the basin's oil discovered through 1987. The potential for a deep sub-thrust play has been mentioned for Block 1's elongated area along the northern basin flank. Also, during Kyrgyzstan's presentation in Houston, Texas, on July 19, 1994, discovery potential was emphasized for the deep sub-thrust section along the south basin flank.

Many comparisons of reservoir depth, porosity, geologic age, and other parameters can be obtained by making use of reservoir-level data available on the computer diskette. Reservoir-level data on this diskette are considered to be the most important part of this report. Again, these diskette data are the same as those available with publication of this report's Advance

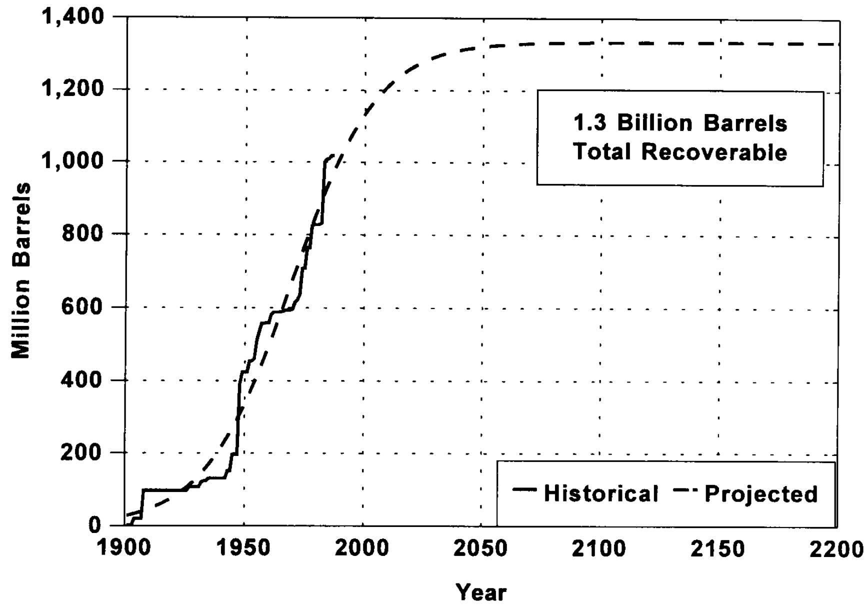
Table 6. Ultimate Recovery of Discovered Oil and Gas by Republic Areas, Fergana Basin (through 1987)

Item	Uzbek Blk. 1	Uzbek Blk. 2	Uzbek Blk. 3	Uzbek Blk. 4	Uzbek Blk. 5	Mingbulak Unoffered Area	Tadzhikistan Areas	Kyrgyzstan Areas	Total Fergana Basin
Number of Oil and Gas Fields Discovered	4.0	3.0	4.5	9.5	8.0	1.0	9.0	14.0	53.0
Ultimate Oil Recovery for Discovered Fields (million barrels)	52.981	81.295	39.033	85.741	232.038	164.869	200.714	161.073	1,017.743
Ultimate Assoc-ciated - Dissolved Gas Recovery for Discovered Fields (billion cubic feet)	31.823	28.757	4.248	45.571	94.347	230.098	94.944	53.832	583.620
Ultimate Non-associated Gas Recovery for Discovered Fields (billion cubic feet)	0.000	14.906	40.898	198.584	64.418	343.852	327.093	790.694	1,780.444

Notes: "Uzbek Blk." refers to 5 license blocks offered by Uzbekistan on August 25, 1993, in Houston, Texas. Ultimate recoveries are the product of estimated quantities in place and their respective estimated recovery efficiencies, and are nearest to the U.S. reserves categories of Proved plus Probable. At least 7 additional fields exist as noted in material presented by Uzbekistan and by Petroconsultants. These 7 fields were probably discovered after 1987: Iskovat (block 1); Alty-Aryk, Karadzhida, Khankyz Sever-N, Rishtan Yuzh-S (block 3); and Sary-Kurgan, Yaipan (block 4). Any new field additions since 1987 are unknown for Uzbek blocks 2 and 5. Totals may not equal sum of components due to independent rounding.

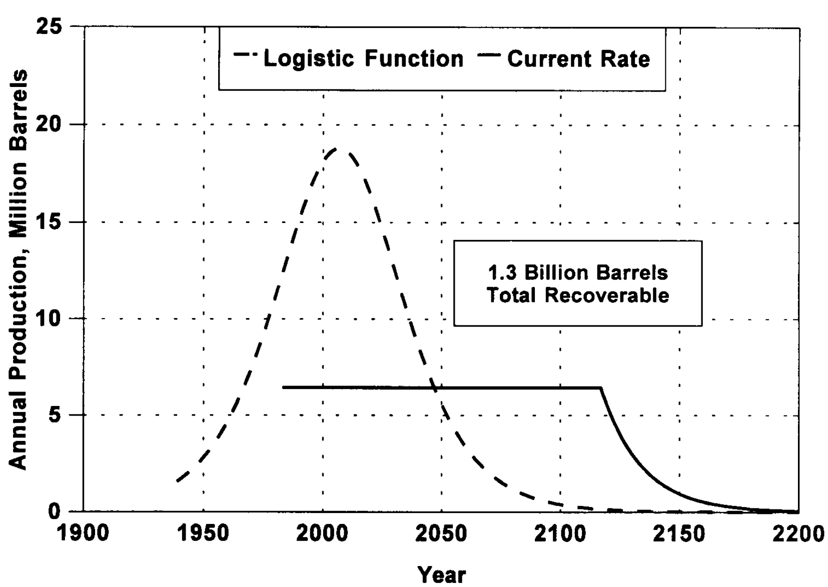
Source: Energy Information Administration, Office of Oil and Gas.

Figure 12. Cumulative Discovery of Total Recoverable Oil, Logistic Function Projection, without the New Deep Central Graben Play, Fergana Basin



Source: Energy Information Administration, Office of Oil and Gas.

Figure 13. Oil Production Projections Based on Logistic Function and Current Rate, without the New Deep Central Graben Play, Fergana Basin



Source: Energy Information Administration, Office of Oil and Gas.

of field ultimate recovery may be quite different than what was estimated when the field was discovered as well as the final estimates when the field is depleted. Generally, estimates of ultimate recovery for a large field will grow over time because initial estimates did not account for additional development, application of improved recovery techniques, etc. (Most growth occurs in the first few years and diminishes with time.) It is the lack of data concerning this field growth over time that makes our cumulative discovery curve different than what may finally be recorded after all fields are depleted. Older fields have the "benefit" of a long period of growth. Recently discovered fields have not had the same opportunity (time) for growth.

However, it is impossible to precisely predict the final discovery history. While the projections based on the discovery history will be different than if based on the final history, the difference should be well within the accuracy of the methods used here.

Oil Potential without the New Deep Central Graben Play

The discovery history directly affects the future discovery rate. A logistic equation was fit to the historical cumulative discovery data to estimate ultimate recovery and future discoveries for the Fergana basin **(Figure 12)**. The logistic function estimated that cumulative discoveries would eventually reach 1.3 billion barrels of recoverable oil. Subtracting the 1 billion barrels of known recoverable oil leaves roughly 300 million barrels of undiscovered recoverable oil in the basin. The logistic equation and fit parameters are as follows:

$$CumDisc_t = \frac{TotRec}{1+a*\exp^{b*(t-t_o)}} \qquad \textbf{(1)}$$

where:

$CumDisc_t$	=	Cumulative Discoveries at time t
$TotRec$	=	Total Recoverable (1,334 million barrels, discovered and undiscovered)
a	=	49.78137, a calibration coefficient
b	=	-0.0563, a calibration coefficient
t	=	time, current year
t_o	=	reference time, year (1900)
exp	=	2.71828, base of the natural logarithm.

The logistic function (Equation 1) was described in 1972 by Dr. M. King Hubbert in his projection of U.S. oil production. This equation generates an "S" shaped curve that is asymptotic to zero when t is small and asymptotic to the Total Recoverable when t is large. Another property of this equation is that the discovery rate grows and eventually decays at the same rate (b in Equation 1) and is symmetrical about some point in time. A logistic function with a symmetrical nature is accommodating for regions with a long development history. In areas where development began recently and quickly, an asymmetrical function may better project future discoveries. Recently developed areas are more likely to have a growth rate that is higher than the eventual decline rate, rather than the same.

The cumulative production curve has the same general shape as the cumulative discoveries curve but with a time lag. The annual change in the cumulative discoveries curve (or derivative), with the appropriate time lag, is the annual production. Normally, the cumulative discoveries curve is shifted in time to match the cumulative production curve, or the annual change in the cumulative discoveries curve is shifted to match the annual production. However, the production history for the Fergana basin is not available for this matching technique. Instead, the annual production curve was shifted in time so that the cumulative production in 1982 matched the cumulative production in **Table 2** (about 334 million barrels). This resulted in a time shift of 37 years. **Figure 13** shows the time-shifted projected annual production as determined from Equation 1 for the Fergana basin. From **Table 2**, annual production from 1982 through 1991 was estimated at 6.44 million barrels per year based on the reported cumulative production in 1982 and 1991. A constant rate projection is also shown in **Figure 13** with the same decline at the end as in the logistic equation projection (5.6 percent). Both projections yield an ultimate recovery of 1.3 billion barrels. Limited resources for development usually keep a producing region from following the projected annual production curve to its peak. Actual production tends to follow the projected curves only so far and then flattens. The constant rate projection of 6.44 million barrels of oil per year is normal and expected.

Oil Potential of the Deep Central Graben

Although **Figures 8 and 13** include the recently discovered Mingbulak field, other potential discoveries from the deep central graben are not included. The U.S. Geological Survey has estimated about 3 billion barrels of oil yet to be discovered in the Fergana basin (modal value, **Table 2**). Subtracting the 300 million barrels estimated for the known historical development above leaves about 2.7 billion to be discovered in the deep central graben (Mingbulak-type structures). Because there is no discovery history, and development is expected to be slow due to anticipated limited investment, the logistics function of Equation 1 was used to construct a possible cumulative discovery curve. The undiscovered oil recovery was fixed at 2.7 billion barrels and the other coefficients were adjusted to create the cumulative discovery curve of **Figure 14**. The cumulative discovery curve is purely hypothetical for the deep central graben potential of 2.7 billion barrels of undiscovered oil. For this case, the logistic equation and fit parameters are as follows:

$$CumDisc_t = \frac{TotRec}{1 + a * \exp^{b*(t - t_0)}} \qquad \textbf{(2)}$$

where:

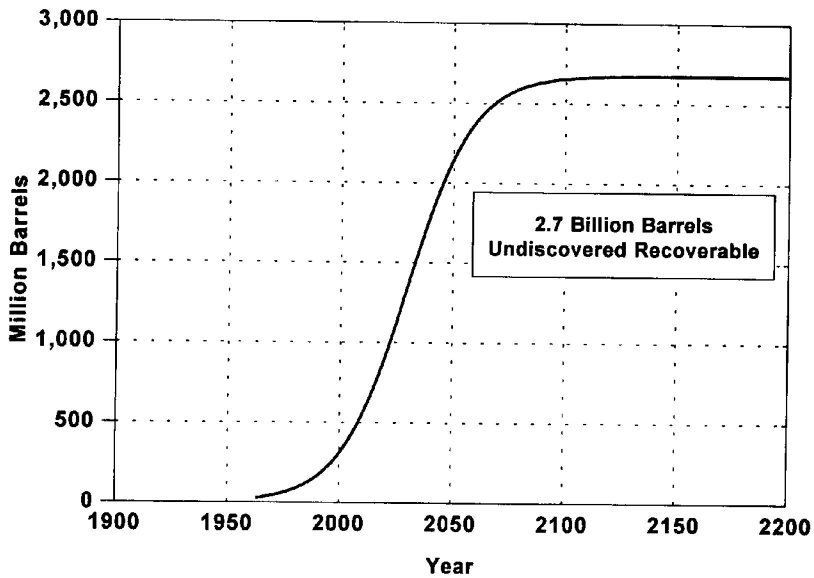
$CumDisc_t$	=	Cumulative Discoveries at time t
$TotRec$	=	Total Recoverable (2,675 million barrels, undiscovered)
a	=	41.15269, a calibration coefficient
b	=	-0.06849, a calibration coefficient
t	=t	ime, current year
t_0	=	reference time, year (1975.4)
exp	=	2.71828, base of the natural logarithm.

These parameters were determined by trial and error from visual inspection of **Figure 14**. The annual change in the cumulative discovery curve **(Figure 14)** with a time lag of 20 years is assumed to be the annual production **(Figure 15)**. In addition to the production projection determined by Equation 2, **Figure 15** shows a constant rate projection of 25 million barrels of oil per year. Limited resources for development usually keep actual production from reaching the peak projected by the logistic equation. In this case, 25 million barrels per year was chosen as the constant rate for departure from the logistic function projection. Both curves in **Figure 17** yield an ultimate recovery of 2.7 billion barrels. Both curves have the same final decline rate of 6.8 percent (Equation 2).

Total Basin Oil Production Projections

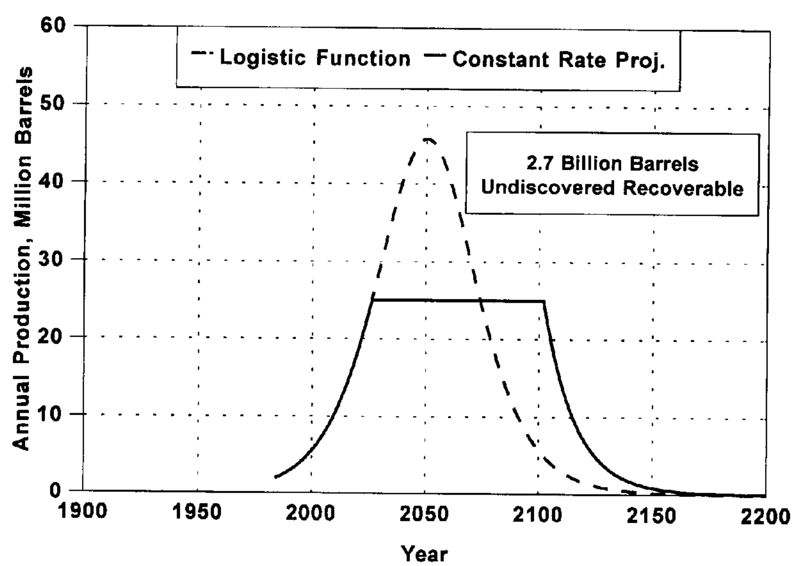
Total basin projections are determined by simply adding the known historical basin projections and the deep central graben hypothetical projections. **Figure 16** shows the historical cumulative discovery curve along with the summation of cumulative discoveries projected by Equations 1 and 2 (or **Figure 12** plus **Figure 14**). The total basin recovery estimate is 4 billion barrels of oil, 1 billion known and 3 billion undiscovered, or 1.3 billion barrels from the known historical development and 2.7 billion from the relatively unexplored deep central graben. **Figure 17** shows the combined production projections for both the logistic equations and the constant rate projections (**Figure 13** plus **Figure 15**). Both curves yield a total recovery of 4 billion barrels. The constant rate projected maximum of 31.4 million barrels per year is about half of the reported charge capacity of the two refineries in the Fergana basin.

Figure 14. Hypothetical Development of the Deep Central Graben Potential, Cumulative Discovery of Undiscovered Recoverable Oil, Fergana Basin



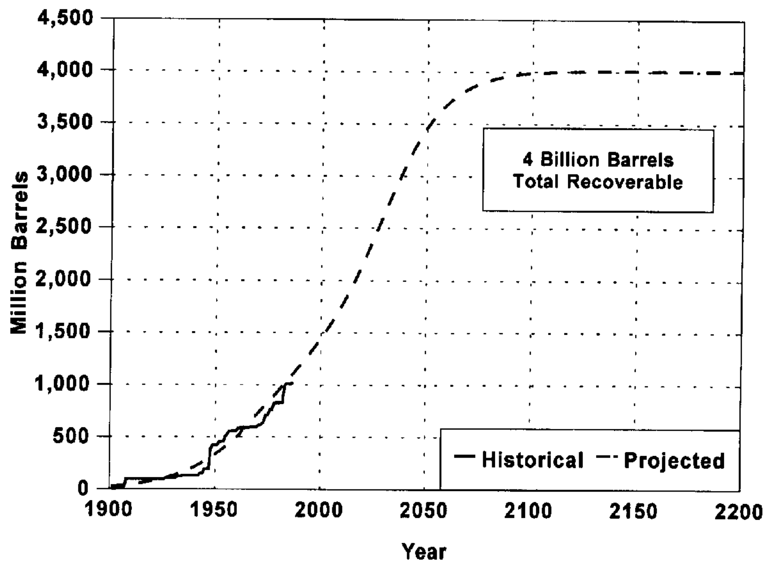
Source: Energy Information Administration, Office of Oil and Gas.

Figure 15. Oil Production Projections for the Deep Central Graben Potential, Fergana Basin



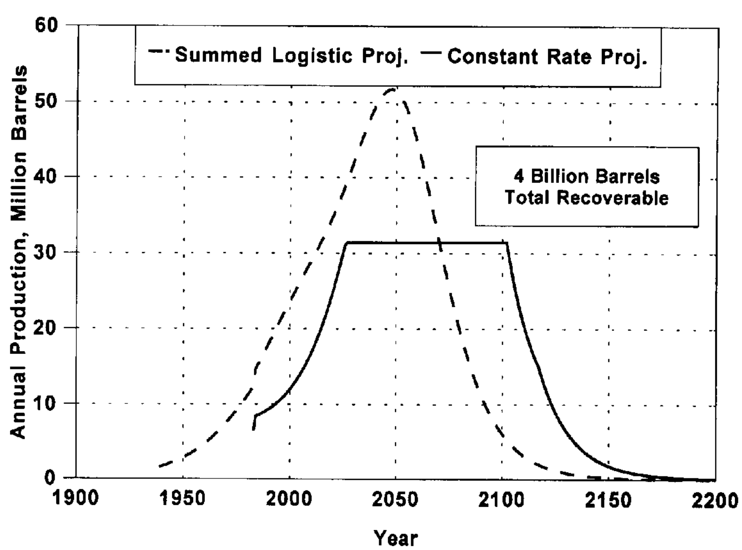
Source: Energy Information Administration, Office of Oil and Gas.

Figure 16. Projected Cumulative Discoveries Including the Deep Central Graben Potential, Fergana Basin



Source: Energy Information Administration, Office of Oil and Gas.

Figure 17. Oil Production Projections Including the Deep Central Graben Potential, Fergana Basin



Source: Energy Information Administration, Office of Oil and Gas.

2. Petroleum Geology of the Fergana Basin

Introduction

The Fergana oil and gas province coincides with the Fergana intermontane basin, which is located in West - Central Asia near the western Chinese border **(Figure 1)**. A central graben is bounded by high-angle reverse faults, similar to the basins of western China, and the entire post-Paleozoic sedimentary section from the Jurassic through the Neogene is productive.

It is generally believed that the Fergana basin's main source rocks are of Jurasic and Paleogene (Paleocene-Eocene-Oligocene) age. The basin's subsurface reservoir seals typically consist of shales. However, this analysis does not address basin-wide source rocks, reservoir seals, or estimated times of oil and gas generation and migration. Detailed discussions of these important issues were not found in the literature. As noted in Appendix C, an overpressure condition appears to begin at depths of about 12,000 feet (3,658 meters). Wells drilled below such depths are primarily in the central basin graben, which is filled with a thick molasse of Neogene and Quaternary clastic sediments.

The Fergana Valley is at the western end of the Southern Tian-Shan orogenic system. The valley floor slopes from an elevation of about 3,281 feet (1,000 meters) on the east to 1,050 feet (320 meters) on the west, where it is drained by the Syr-Dar'ya River **(Figure 2)**. The valley is about 186 miles (300 kilometers) long and 109 miles (175 kilometers) wide; its area is about 14,672 square miles (38,000 square kilometers). At the western mouth of the valley is the city of Khuzbad (formerly Leninabad), which was founded in 329 B.C. by Alexander. In the 13th century, the army of Genghis Khan is said to have wintered in the valley and collected a waxy substance for lubricating the wheel axels of its carts (Hardy, 1994). This substance may have been ozocerite or another such bitumen collected from surface exposures or shallow pits dug into the surface seals of oil seeps.

The Fergana Valley is bounded on all sides by high mountains whose year-round snows and glaciers furnish abundant water to the valley. As a result, the stream valleys and irrigated areas support a lush vegetation, whereas, at short distances from the water, the land becomes desert. In addition to a thriving agricultural economy, the valley also produces oil, gas, ozocerite, coal, gypsum, copper, mercury, antimony, radium, uranium, and cement (Clarke, 1984).

Political boundaries within the valley are very complicated, having been drawn on the basis of the predominant ethnic group. Territories of 3 of the 15 former Soviet Socialist Republics lie in the valley -- Uzbekistan, Kyrgyzstan and Tadzhikistan **(Figure 2).** The Uzbeks are an agricultural people and occupy the flat land, whereas the Kirghizians and Tadjiks are shepherds and live in the hilly country. This "Cain and Abel" confrontation is manifest even sometimes today when one group uses a particular name for a geologic feature, whereas another group uses a different name.

Stratigraphy

General Geologic History

More than 30 petroleum pay zones or horizons are recognized in the Paleozoic-Cenozoic section of the Fergana basin. These are designated I through XXXII in order of increasing depth. Most of these pay zones are indicated with their formational names in **Figure 3.**

Paleozoic rocks form the mountains surrounding the Fergana basin and are exposed through the sedimentary fill at places along the borders of the basin. These rocks consist of thick miogeoclinal limestones, shales and phyllites, sandstones, and volcanics. The total measured thickness of the Paleozoic section is about 33 to 49 thousand feet (10 to 15 kilometers). These indurated rocks range in age from Cambrian through Permian and are mildly metamorphosed in places. Granitic plutons invaded the sedimentary pile during the Permian Period in the final phase of the Hercynian orogeny.

Following the Hercynian orogeny the region entered a platform tectonic stage. In some areas, however, normal sedimentary rocks of Late Permian and Early Triassic age form an intermediate complex between the miogeoclinal rocks beneath and the platformal deposits above (Glumakov and others, 1988). Pay zone XXX is in this intermediate complex (**Figure 3**). The Middle and Late Triassic were times of emergence and erosion. Then the region began to subside to become the Mesozoic-Cenozoic basin of deposition, a part of the Tethyan Sea. The basin was bordered on the north by the Kazakh Plateau, which was the principal source area for sediment. The sea extended hence southward, interrupted by an island, which coincided with the present Alay Mountains; these mountains gained their present high elevation only in the late Tertiary with the Alpine orogeny.

Jurassic System

The oldest rocks of the sedimentary fill in the Fergana basin are Lower Jurassic conglomerates and sandstones. Coal beds are present in some places (Beznosov, 1987). These rocks crop out along the margins of the basin and are at depths of as much as 22,966 feet (7,000 meters) in the central parts. Thickness is commonly around 328 feet (100 meters); however, thicknesses up to 2,625 feet (800 meters) are recorded (Khodzhayev and others, 1973; Glumakov and others, 1988).

The Middle Jurassic consists of sandstone, siltstone, clay and some coal. Plant remains as well as freshwater mollusks are abundant. Thickness ranges from about 328 to 984 feet (100 to 300 meters).

The Upper Jurassic is composed of redbeds and conglomerates, each predominating at one place or another. No coal is present, and plant fragments are rare. Thickness ranges from about 164 to 1,312 feet (50 to 400 meters) (Verzilin and others, 1972).

Sandstone pay zones within the Jurassic are designated from the top downward, XXIII through XXIX **(Figure 3)**.

Cretaceous System

The Cretaceous sediments also crop out along the fringes of the basin and are at depths of more than 19,685 feet (6,000 meters) in the central part of the basin. They cover, at the surface, large areas along the eastern, southeastern, and southern parts. Twelve sandy pay zones (XI-XXII) are present (**Figure 3**). These zones characteristically shale out toward the interior of the depression.

The redbed deposition of the Late Jurassic continued into the Early Cretaceous with accumulation of conglomerates, sandstones, and clays of the Muyan formation of Neocomian-Aptian age (Khodzhayev and others, 1973). Total thickness of this formation ranges from about 16 to 984 feet (5 to 300 meters), and it is host to pay zones XIX-XXII.

Next upward in the section is the Lyakan formation of early Albian age; it consists of 98 to 262 feet (30-80 meters) of gray to pink limestone. Along the north and northeast border of the depression this formation consists of sandstones containing beds of limestone and marl; it is designated pay zone XVIIIg.

The Upper Albian is represented by the Kyzyl-Pilyal formation, which is composed of red sandstone and clay, 16 to 1,312 feet (5-400 meters) thick. The presence of palygorskite (attapullgite) among the clay minerals indicates an arid climate and a high salinity for the basin. Some gypsum was deposited in the south part of the depression at this time (Verzilin and others, 1973). The Kyzyl-Pilyal contains pay zones XVIIIa, XVIIIb, and XVIIIv.

The Kalachin formation of Cenomanian age is next upward in the section. It consists of conglomerates in the west, passing eastward into sandstone. Thickness increases from about 16 feet (5 meters) in the west of the basin to about 1,575 feet (480 meters) in the east. No pay zones are present in the Kalachin.

The Ustricha (oyster) formation of early Turonian age is largely carbonate. Toward the source area on the north, however, it passes into redbeds. Thickness ranges 98-131 feet (30-40 meters) along the borders of the basin to about 525 feet (160 meters) in the interior. Pay zones XVI and XVII are within this formation.

The Yalovach formation of late Turonian-Senonian age consists almost entirely of variegated sands and argillaceous sands and argillaceous sandstones. It contains pay zone XVa. Thickness ranges from 49 to 66 feet (15-20 meters) on the borders of the basin to about 820 feet (250 meters) in the interior.

At the top of the Cretaceous System is the Senonian Pestrotsvet (variegated) formation. In the southwest it is largely gypsiferous marl of various colors. Then toward the east it changes into limestones and sandstones. Pay zones XI-XV are present in this formation. Some workers recognize the Changyrtash formation containing zones XII and XI within the uppermost Pestrotsvet (Khodzhayev, 1969).

Paleogene (Paleocene-Eocene-Oligocene) System

During the Paleogene the area of the present Fergana depression was part of the Tethys epicontinental sea, which extended westward to the Caspian Sea and thence across Europe to the Atlantic Ocean (Gekker and others, 1962). Land was to the north and east, open sea on the southeast, and land on the south where the area of the Alay Mountains was an island in this sea (**Figure 2**).

As indicated in **Figure 3**, the Paleogene section contains eight pay zones (II-III to X). At the base of the Paleogene is a white gypsum unit, the Goznau, which ranges in thickness from 7 to 33 feet (2-10 meters) in the west of the basin to 262 to 328 feet (80-100 meters) in the east. It is Paleocene in age and is designated as pay zone X. Above the gypsum and still within the Paleocene are clastic deposits (pay zone IX) and then limestones (pay zone VIII), which together form the Bukhara beds.

The lower Eocene is represented by the Suzak beds, which range in thickness from about 33 feet (10 meters) in the west to 295 feet (90 meters) in the east. The Suzak consists of clays and beds of sandstone and siltstone, grading upwards into limy clays and dolomites; this formation is not petroleum productive.

The middle Eocene Alay beds are divided into a lower clay unit and an upper carbonate (pay zone VII). Thickness is 33 to 525 feet (10-160 meters).

The upper Eocene rocks begin with the Turkestan beds, which are composed of lower and upper green clays separated by thin limestone beds (pay zone V). In the eastern part of the basin beneath the limestones is a gray dolomite member (pay zone VI.) Thickness of the Turkestan is about 164 feet (50 meters).

Next upward in the upper Eocene are the Rishtan beds. In the lower part are limestones and sandstones (pay zone IV), which grade upward into limestones and marls and then into clays. Rishtan thickness is about 131 feet (40 meters).

At the top of the Eocene are the Isafara beds, which consist of 98 feet (30 meters) of clay.

The lower Oligocene is represented by the Khanabad Beds, which are almost entirely green clay and are 98 to 131 feet (30-40 meters) thick.

The Sumsar beds of middle Oligocene age begin with marl and pass upward into clay and then clayey sand. Pay zone III is this upper sand, which in the west of the basin is designated as pay zone II.

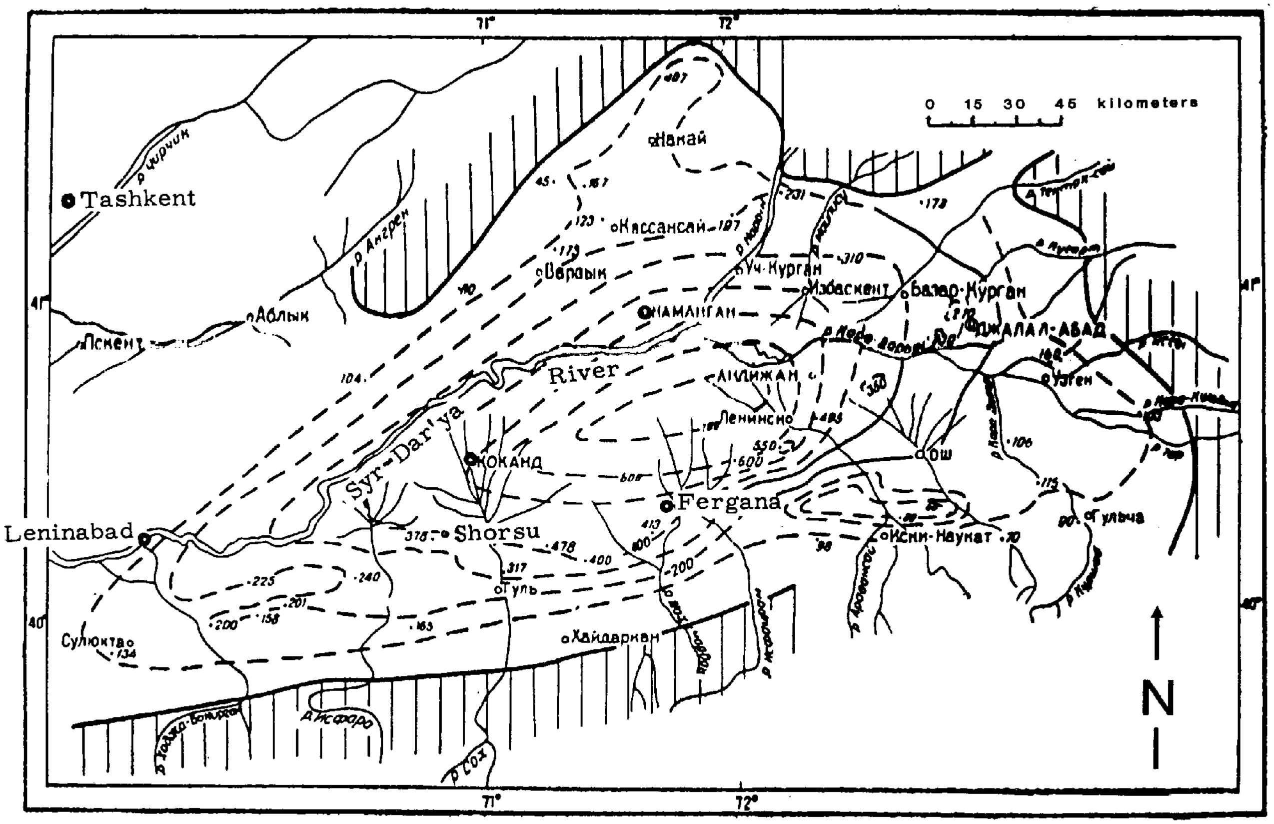
The sea that covered the region of the Fergana basin during the Paleogene retreated after the middle Oligocene as the area passed from a platformal stage to an orogenic stage (Nalivkin, 1973). There was no marine deposition after the middle Oligocene. Total thickness of the Paleogene (Paleocene-Eocene-Oligocene) section ranges from less than 328 feet (100 meters) on the borders of the basin to more than 2,297 feet (700 meters) in its center (**Figure 18**).

Neogene (Miocene-Pliocene) System

Tectonic movements during Neogene (Miocene-Pliocene) time, associated with the Alpine orogeny, resulted in the growth of high mountains along the margins of the basin. Debris shed from these mountains accumulated in the basin to form what is called the Cenozoic molasse. Its composition is variable, and it is almost completely devoid of fossils. Two stages are present: the Massaget and the Baktria (Khodzhayev and others, 1973).

In the lower part of the Neogene section is the Massaget stage, which consists of the "brick-red" and "pale-pink" formations. Both of these are sandstones, siltstones, and conglomerates, and are more than 13,123 feet (4,000 meters) thick in the center of the basin, thinning toward the borders to a few hundred

Figure 18. Thickness in Meters of Paleogene (Paleocene-Eocene-Oligocene) Marine Sediments in the Fergana Basin



Note: Thicknesses represented by dashed isopachous contour lines show maximum 700 meters (2,297 feet) near basin's center. Minimum thickness contoured is 100 meters (328 feet), near the basin's edge. Contour interval is 100 meters.
Source: Slightly modified from Ryshkov (1959).

meters. One of these brick-red sandstones, considered to be Miocene in age, is the upper oil reservoir for the Mingbulak field, and is reported to be about 125 feet (38 meters) thick.

The Baktria stage overlies the Massaget and is composed largely of gray and brown sand and clay beds; conglomerates predominate along the borders of the basin. Like the Massaget, the Baktria thickness is again, about 13,123 feet (4,000 meters) in the center of the basin.

Quaternary sediments are present in the central part of the depression, where they are up to 1,640 feet (500 meters) thick.

Structural Geology

Primary Stages

The region of the Fergana oil-gas province has passed through three tectonic stages of development. The first was miogeoclinal, closing out at the end of the late Paleozoic Hercynian orogeny. The second was a platformal stage, which spanned the time from late in the Permian or early in the Triassic until the middle of the Oligocene. The third was an orogenic stage, the Alpine, which began in the late Oligocene and continues at the present (Khodzhayev and others, 1973).

Miogeoclinal Stage

The Paleozoic rocks of the region were deposited in a miogeocline, which extended for thousands of kilometers from the Gobi Desert and beyond on the east through the Fergana region into central Uzbekistan where it turned northward into the Ural miogeocline and, apparently, also extended off to the west part to be part of the European paleo-Tethys Sea. The seaway closed in Moskovian time along the Sarykamysh fault (**Figure 19**). The miogeoclinal sediments were tightly folded, lightly metamorphosed, and intruded by Permian granites. An autochthon and four allochthonous thrust sheets are now recognized in the region (International Geological Congress, 1984; Zubtsov and others, 1974).

Platform Stage

Following the Hercynian orogeny, the study area in Late Permian time became part of a large cratonal mass (Pangea), which included most of the continental area of the Earth at that time. During the Triassic, the region was emergent and subject to erosion. Beginning with the Jurassic, however, the area subsided and was inundated by an epicontinental sea, part of Tethys, which occupied the area almost continuously until the end of middle Oligocene time.

The area of the present Alay Mountains on the south was an island in this epicontinental sea; however, this was not a mountainous area because it does not appear to have been a source for coarse clastics. The high elevations of the Alay Mountains came later in association with the Alpine orogeny. Open ocean lay to the south of the Alay island. The marine basin coincided generally with the present Fergana Valley, and the main source area for sediment was the Kazakh Plateau to the north.

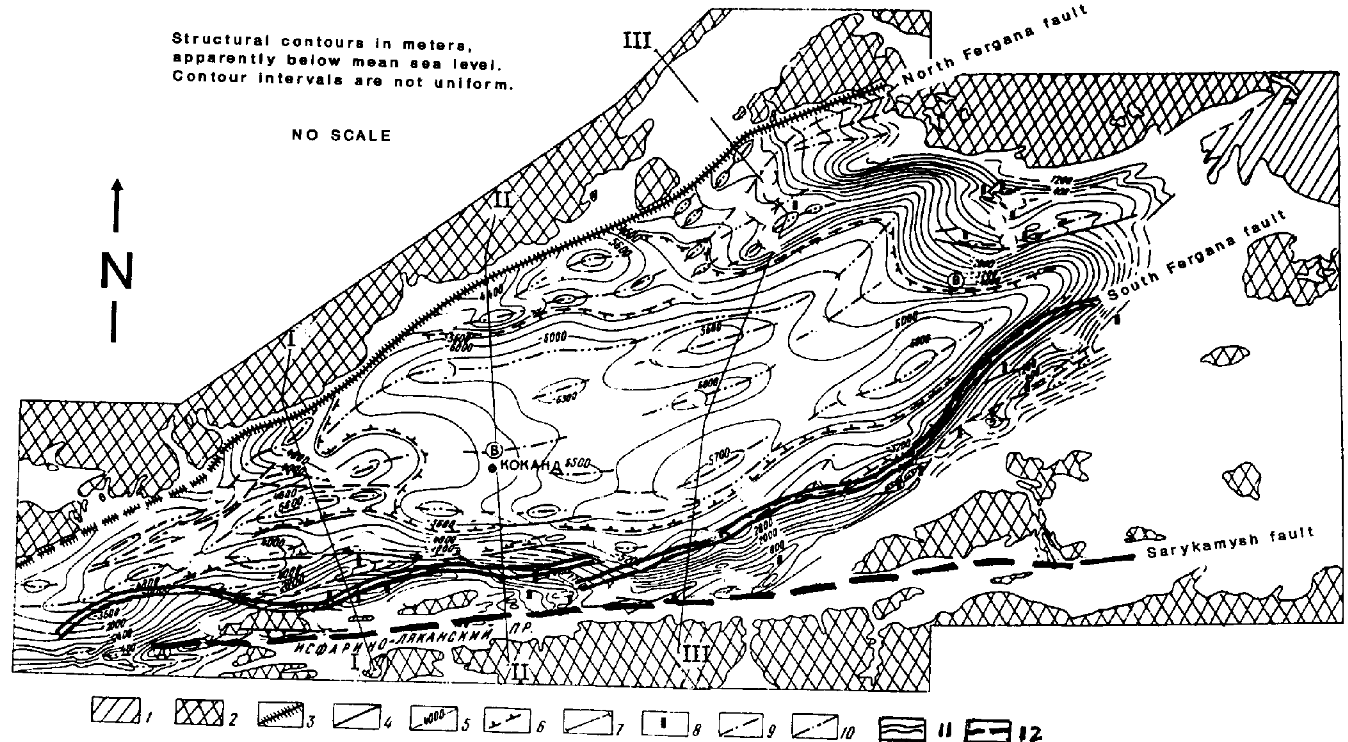
Movement took place along high-angle faults during the platform stage. Some of these faults were reactivated Paleozoic faults, whereas others had their first movement during the Mesozoic and Paleogene.

The platformal stage ended when the area became involved in the Alpine orogeny beginning in late Oligocene time.

Orogenic Stage

The central structural feature of the Fergana oil-gas province is the Fergana graben, which is one of the "West China" basins that formed in Tertiary time in response to the collision of India with the Asiatic continent (**Figure 20**). Compressional and wrench movements resulted in the basins being bounded by high-angle reverse faults. The trend of the faults along the border zones is in general parallel to trends in the folded Hercynide basement. Total vertical displacement in these border zones is as much as 26,247 feet (8 kilometers). The Paleozoic basement in the central part of the graben, according to geophysical data, is at depths of about 32,808 feet (10 kilometers, Diken-

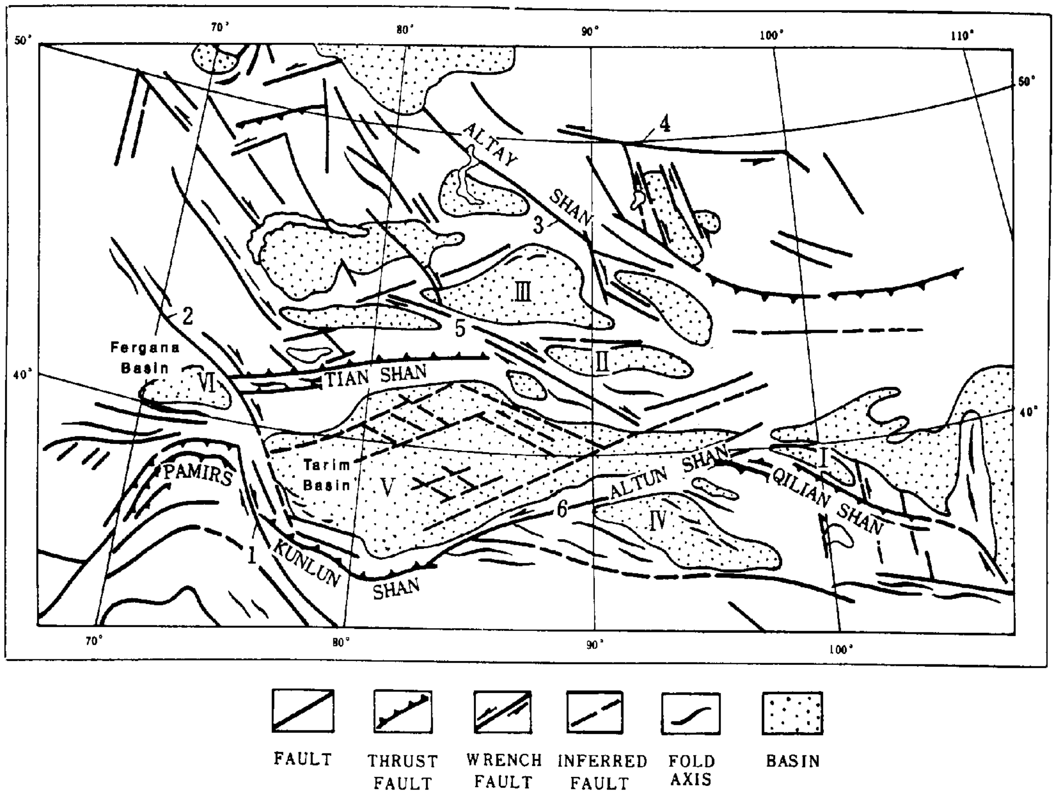
Figure 19. Structure Map, with Subsurface Contours at Base of Mesozoic Section, Fergana Basin



1-2-Basement rocks of the depression; 3- North Fergana fault; 4-other faults; 5-structure contours on base of Mesozoic section; 6-boundaries of structural units; 7- profiles; 8-oil and gas fields; 9- axes of anticlinal zones; 10-axes of synclinal zones; 11- South Fergana fault; 12-Sarykamysh fault.

Note: Structural contour closures have both anticlinal and synclinal axes. Profile lines I-I, II-II, and III-III indicate cross-section locations, as shown in Figure 22. No scale was provided, but the map distance northeast from Kokand (east-central basin) to Isbaskent, in the northeastern group of fields, is roughly 75 miles (121 kilometers).
Source: Modified from Khodzhayev, et al (1973).

Figure 20. Sketch Map of Xiyu Tectonic Domain, Northwest Part of China and Adjacent Regions, Including the Fergana Basin



Sketch map of Xiyu tectonic domain, northwest part of China and adjacent regions. Basins: (I) Jiuquan, (II) Turpan, (III) Junggar, (IV) Qaidam, (V) Tarim, and (VI) Fergana. Faults: (1) Karakorum, (2) Talaso-Fergana, (3) Ertix, (4) Changajn, (5) Boro-horo, and (6) Altun Shan.

Note: Caption and legend reprinted from source Figure 12. Map annotation was added for Fergana and Tarim basins.

Source: Liu Hefu (1986), reprinted by permission from American Association of Petroleum Geologists (AAPG Bulletin, April 1986, p. 387).

shteyn and others, 1983). The graben began to form in late Oligocene time.

The North Fergana fault zone (**Figure 19**) coincides with a relatively sharp boundary between the graben lowlands with Neogene clastic fill on the south and the Paleozoic Hercynides of the north mountainous region. The horizontal (southward overthrust) component of some of the reverse faults of the North Fergana fault zone is not less than 3.1 miles (5 kilometers) (Gotfrid and Puchkov, 1980; Gotfrid and others, 1983). Anticlines on Paleogene and Upper Cretaceous sediments beneath these overthrusts are exploratory targets.

The South Fergana fault zone (**Figure 19**) bounds the Fergana graben on the south; this fault, however, lies within the topographic valley. To the west it is about 31 miles (50 kilometers) north of the base of the Turkmen and Alay Mountains; then at approximately longitude 70° 40'E the fault zone changes its trend to northeast and extends hence farther into the topographic valley (**Figure 19**). Drag along the fault has resulted in vertical dips in places.

Potential exploratory targets for additional deep drilling are indicated by cross-section "B" of **Figure 21** (original Figure 11 in below-figure legend notes). In this figure, Fergana basin structural development is compared for extensional (upper cross-section "A") versus compressional (lower cross-section "B") mechanisms. The reason for including this highly diagrammatic and conjectural figure is not to discuss which of the two mechanisms may be more correct. The point here is to suggest that reservoir targets beneath the overthrusts may exist and be reached by deep drilling on the basin flanks. Detailed seismic or other geophysical data were not available for this study. However, seismic profiles displayed at the Uzbek and Kyrgyz block offerings contain interpretations of toward-basin thrusting and high-angle reverse faults on the north and south basin flanks. Detailed seismic surveys on the basin flanks, coupled with deep drilling, would reveal more of this complex structure.

While many two-dimensional seismic profiles have been shot and common-depth-point processing applied, the results of any seismic modeling are unknown. The degree of interval detail for velocity modeling may be rather coarse for most horizontal profiles. Some vertical seismic profiling has been done. While **Figure 11** shows the configuration of seismic lines across the Mingbulak structure, such density is naturally not expected across the rest of the basin. Basically, it is doubtful if modern seismic data processing has been widely performed. Western companies would likely augment existing data with new seismic surveys for an extensive exploration program, or even launch three-dimensional seismic surveys for selected development projects.

The Fergana graben is clearly a graben in some parts, being bounded on both flanks by high-angle reverse faults (**Figure 22**, middle cross-section II-II). In other places, however, it is more a half graben, flexuring accounting for most of the downdrop on the south flank (**Figure 22**, upper cross-section I-I). **Figure 22's** cross-sections are related to and located on **Figure 19's** structural map.

The principal faults of the study area appear as lineaments on satellite images (Trifonov and others, 1975, p. 359). The anticlines of the Fergana basin are largely fault-associated, having formed along the numerous longitudinal faults that developed during the time of graben subsidence.

Petroleum Pay Zones

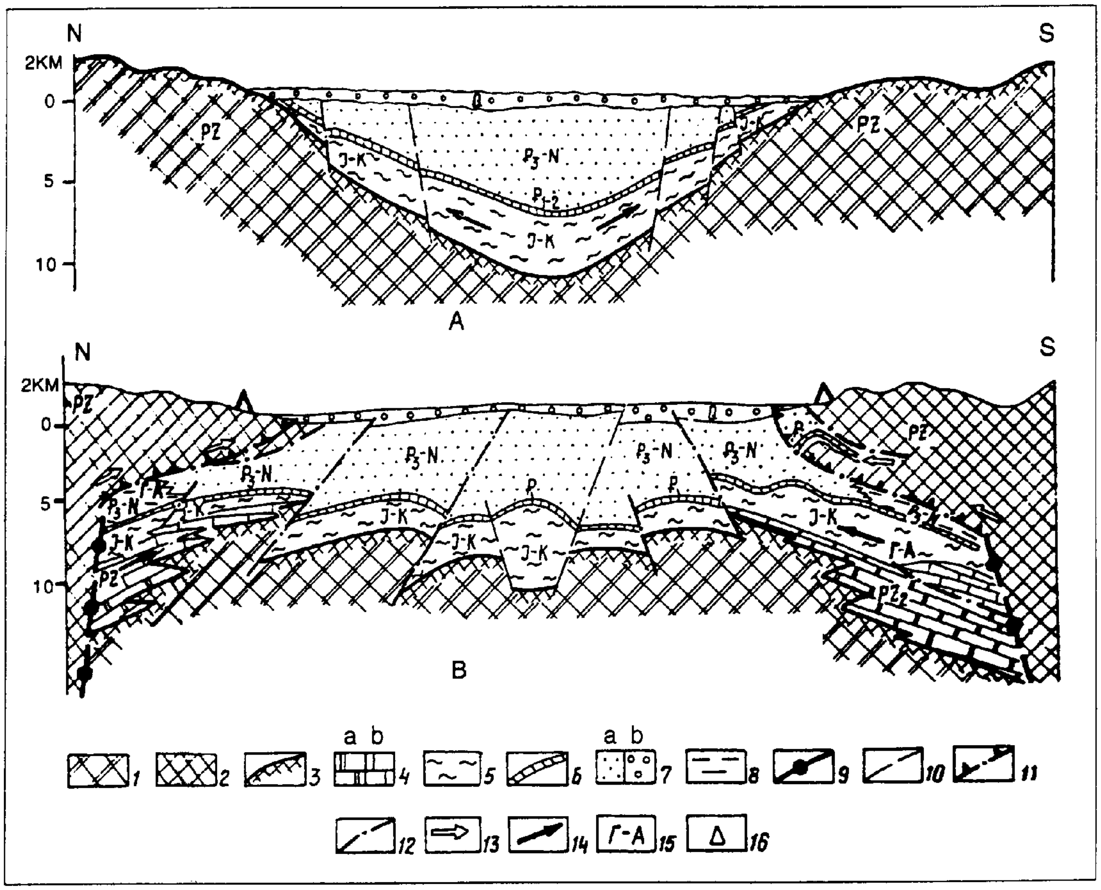
Overview

Oil and gas reservoirs occur in some part of every major sedimentary unit of the Fergana basin including Neogene, Paleogene, Cretaceous, Jurassic, and the Upper Permian-Triassic intermediate complex. Oil has been recovered in the region since ancient times. Seeps in Paleogene sediments became sites of hand-dug wells, and shows of oil are even now common in road cuts.

The first drilling was in 1880, and some minor oil was produced in the Shorsu area, which is south of Kokand **(Figures 2 and 18)**. Only three fields were discovered in the period of 1900-1919 (Maylisay, Chimion, Kim). Total production for the province between 1885 and 1917 was 3.6 million barrels (488,000 metric tons) of oil.

After nationalization, development of the Shorsu IV field began in 1927 and production in the basin rose to

Figure 21. Cross-Section Comparison Between Traditional Model (extensional - upper diagram) and Plate Tectonic Model (compressional - lower diagram), with Speculative Deep-Flank Drilling Prospects, Fergana Basin

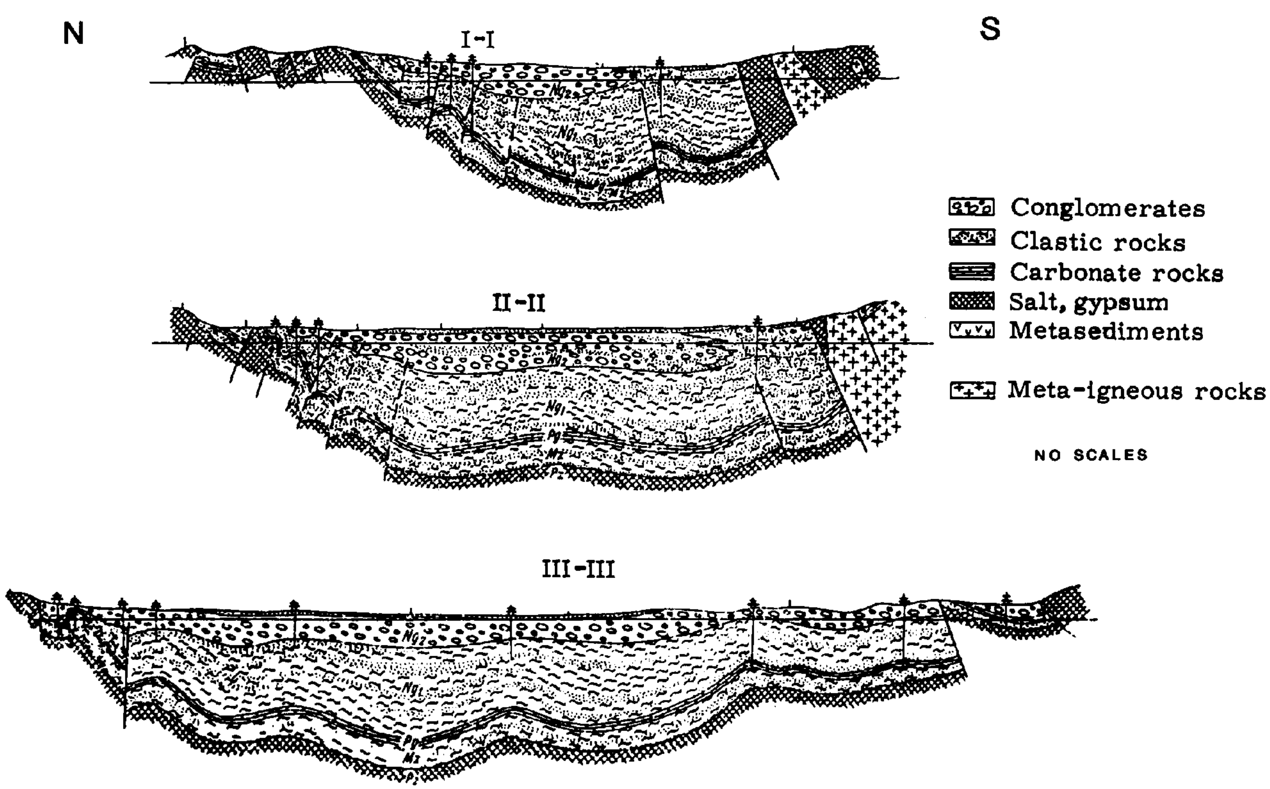


Comparison between the traditional and plate tectonic models of Fergana petroliferous basin: (A) traditional model of geological structure; (B) plate tectonic model (Yablonskaya, 1989). 1 = Paleozoic autochthonous deposits (base); 2 = Paleozoic allochthonous deposits of a collisional orogen (folded basement); 3 = folded basement surface; 4 = Paleozoic deposits having accumulated at geodynamic settings of microcontinent passive margins, marginal seas, and straits (a = autochthonous, b = allochthonous); 5 = rift and above-rift deposits, Lower Jurassic–Cretaceous; 6 = main regional oil- and gas-bearing formation (Paleogene); 7 = Oligocene quaternary collision orogen deposits (a = continental molasse, b = supposed marine deposits); 8 = North Fergana and South Fergana sutures; 9 = faults; 10 = North Fergana and South Fergana main thrusts foot; 11 = thrusts, upthrusts; 13 = direction of allochthonous mass transport; 14 = main direction of hydrocarbon migration; 15 = extra hydrocarbon generation and accumulation centers; 16 = recommended areas for oil and gas exploration. Q = Quaternary; N = Neogene; P_3, P_2, P_1 = upper, middle, lower Paleogene; K = Cretaceous; J = Jurassic. See Figure 2 for location.

Note: Caption and legend reprinted from source Figure 11. Symbol 6 in legend represents Paleogene (Paleocene-Eocene-Oligocene) section containing the main oil- and gas-bearing formations. Inverted "V" symbols on basin's north and south flanks (compressional - lower diagram) indicate surface locations for speculative vertical drilling prospects.

Source: Khain, Sokolov, Kleshchev, and Shein (1991), reprinted by permission from American Association of Petroleum Geologists (AAPG Bulletin, February 1991, p. 321).

Figure 22. Schematic Geologic Cross-Sections, Fergana Basin



Note: Profile line locations for cross-sections are shown on Figure 19. Cross-sections are essentially north-to-south (left-to-right), across the basin.

Source: Slightly modified from Khodzhayev, p. 76 (1969).

370 thousand barrels (50,000 metric tons) of oil per year. Eight fields were discovered in the 1933-1936 period in Paleogene reservoirs (Tulyaganov, 1977).

In 1947, deeper drilling found commercial oil and gas in Upper Cretaceous reservoirs of the Palvantash and Andizhan fields. Cretaceous discoveries were later made in Yuzhno-Alamyshik (South Alamyshik), Izbashkent, Khodzhiabad, and other fields. Eleven fields were discovered during the 1951-1961 period.

About 1960, exploration was intensified along the northern border of the Fergana graben. The Namangan oil field was discovered in 1959, Maylisu III in 1962, and Kyzul-Alma in 1966. Later intermittent discoveries appear to be concentrated in the southeastern portion of the basin.

A total of 229 reservoirs were known in the basin according to Akramkhodzhayev and others (1982). These are largely in the Paleogene sediments (**Figure 3**). Glumakov and others (1988) list 57 commercial fields. Analyses in this report were performed on 53 fields or combinations of fields.

Upper Permian-Triassic Pays

This transition complex constitutes a subbasin and has three pay zones--XXXII and XXXI in the Madygen formation and XXX in the Kokiin formation. These consists of conglomerate and sandstone (Glumakov and others, 1988).

Jurassic Pays

Seven pay zones, XXIX through XXIII, are present in the Jurassic section. Zone XXIX is in the Toarcian Stage, and XXVIII is in the Aalenian. They are friable sandstones. Zones XXVII, XXVI, and XXV are Bajocian and consist of sandstones that range in total thickness from about 328 feet (100 meters) in XXV to 39 feet (12 meters) in XXVI. Porosity ranges from 16 to 22 percent, and permeability ranges from 100 to 500 millidarcies. Sandstones XXIV and XXIII are Bathian, and total thickness of each is about 49 to 131 feet (15-40 meters). Porosity ranges from 15 to 22 percent, and permeability ranges from 100 to 300 millidarcies. The Jurassic sediments are largely gas-prone.

All seven pay zones are present in some sections in the southern part of the province. Elsewhere, only zone XXIII is found.

The Jurassic oils contain up to 22 percent paraffin and often do not flow at 68 degrees Fahrenheit (20 degrees Celcius). Their density ranges widely from about 33 to 50 degrees API gravity (0.86 to 0.78 grams per milliliter). Jurassic oils generally are also high in tar and asphalt. The gas is 70 to 80 percent methane, 2 to 4 percent ethane, and 1.5 to 2.5 percent heavier hydrocarbons. Nitrogen content rarely is as much as 20 percent.

The source beds for the Jurassic gas and oil appear to be coal-bearing rocks of the Lower and Middle Jurassic section. Reservoir seals are the clay beds interbedded with the sandstone pay zones. The traps are anticlines, and some Jurassic reservoirs are displaced off structure, hydrodynamically. There is no significant hydrodynamic connection between the Jurassic section and the overlying Cretaceous beds (Semashev and Podgornov, 1979).

Cretaceous Pays

Sixteen pay zones are recognized in the Cretaceous System in the province. Zones XXII, XXI, XX, and XIX are in the Muyan formation; XVIIIg in the Lyakan; XVIIIa, XVIIIb, and XVIIIc in the Kyzyul-Pylyal; XVII and XVI in the Ustricha; XVa in the Yalovach; and XV, XIV, XIII, XII, and XI in the Pestrotsvet. Most of the reservoirs are gas; a few oil "rings" and oil pools are found.

The Cretaceous reservoir rocks are mostly sandstone, but in some places they are interbedded sandstone and limestone or just limestone. Porosity ranges from 6 to 24 percent, and permeability ranges from tens to several thousand millidarcies. The sandstone reservoirs lose porosity toward the central part of the basin due to increasing clay content. Other reservoir beds pinchout on approaching the margins of the basin, suggesting the presence of stratigraphic traps (Kalomazov and others, 1980, 1980a).

Methane content of the Cretaceous gas is 70 to 90 percent, and as much as 6 percent ethane may be present, as in zone XXI of Sharikhan-Khodzhiabad field (Zharbrev, 1983).

Possible source beds for the Cretaceous fields are in sections containing clays and carbonates of the lower and middle Aptian, Cenomanian, and Turonian Stages. Hydrocarbons were probably generated far downdip in the basin where the units are higher in clay and then migrated updip into anticlinal traps. Gas may also have migrated up from the Jurassic sediments before the latter became isolated hydrodynamically. Although the Jurassic and Cretaceous oils differ from one another, there is no apparent difference in their gases. Sufficient clay beds are present in the Cretaceous section to act as seals. Although the Cretaceous oils have the geochemical signature of a continental origin, the stratigraphy suggests strongly a marine origin.

Paleogene Pays

Nine pay zones are present in the Paleogene section. The Goznau white gypsum unit, pay zone X, is overlain by gray quartz sands of zone IX and the limestones of zone VIII. These are the Bukhara beds (**Figure 3**).

One oil reservoir has been found in zone X. Zone IX is productive in only a few areas. Total thickness is up to 82 feet (25 meters), and effective thickness (net pay) is 1.6 to 20 feet (0.5-6 meters). Permeability is up to 150 millidarcies. The limestones of zone VIII are sandy in the west of the basin and grade into limy sandstones in the north. Thickness is 49 to 115 feet (15-35 meters) and permeability is up to 500 millidarcies. This zone is regionally productive.

Zone VII in the middle Eocene Alay beds is a limestone that is divided into three members by clay beds. Seventeen reservoirs are known in this zone; it, and zone V are the most prolific producers in the Fergana basin.

Zones VI (gray dolomite) and V (limestone) are in the Turkestan beds. Zone VI is a light gray anhydrite that contains beds of gray limestone. It is present only in the west and south portions of the basin. Total thickness is 66 to 98 feet (20-30 meters), and net pay thickness is up to 33 feet (10 meters). Porosity ranges from 12 to 18 percent and permeability is up to 150 millidarcies. Zone V contains 18 pools and has been produced since 1904 in the Chimion field (Khodzhayev, 1969). In 1901, zone V was found in the Maylisay field, on the northern flank of the basin. This is a fractured gray limestone, which is persistent areally and is productive in almost all parts of the basin. Total thickness is 49 to 66 feet (15-20 meters), and net pay thickness is 16 to 49 feet (5-15 meters). Porosity ranges from 6 to 30 percent, and permeability ranges from 50 to 600 millidarcies.

Zone IV is in the lower part of the Rishtan beds. It consists of a dense gray limestone grading upward into fine-grained sandstone. Oil and gas reservoirs occur in both the limestone and sandstone. This zone shales out in the eastern and northern portions of the basin.

Zones III and II are in the Sumsar beds and are composed of the fine-grained limy sand and sandstones. Zone II is the western equivalent of zone III. Total thickness is 49 to 98 feet (15-30 meters), and net pay thickness is 33 to 49 feet (10-15 meters). Porosity ranges from 10 to 12 percent, and permeability is up to 300 millidarcies.

The Fergana region during Paleogene time was largely a marine basin, the sea entering from the south and detritus deposited from the north. The marine shales were both source beds and seals. Some pools are sealed updip by bitumen (Khalimov and others, 1983). The reservoir rocks are both limestones and sandstones. Most of the pools are on anticlinal structures. Since these anticlines are commonly faulted, many reservoirs are combination fault-structure traps. The Paleogene rocks are at depths of 19,685 (6,000 meters) in the center of the basin; consequently, conditions may be favorable for updip migration from source beds at increasing depth of occurrence toward the central part of this basin.

Zone VII and V are regionally gas-bearing (Vlasova, 1980). The other zones yield both oil and gas. The oils of the Paleogene reservoirs have a geochemical signature (phytane/pristane) that is characteristic of a marine origin. This is in contrast to a continental origin indicated for the Cretaceous and Neogene oils (Akhundzhanova and Kalinko, 1982).

Neogene Pays

Commercial oil has been found in the Neogene sediments in only a few fields. The reservoirs are in coarse-grained sandstones and conglomerates at the base of the Baktria stage (pay zone I) and in the "pale-pink" and "brick-red" formations of the Massaget stage. Geochemically, the Neogene oil is continental in origin, an interpretation that agrees with the stratigraphy. While inquiries have been made, the origin of oils from the Mingbulak field remain unknown to the authors.

Bitumen Deposits

Deposits of ozokerite and kerite commonly occur on anticlines and in fault zones along the north and south borders of the Fergana basin. These are varieties of a dark paraffin wax consisting primarily of hydrocarbons. The ozokerite deposits are usually at the head of an oil-bearing stratum, sealing the reservoir. These are more common in Paleogene sediments (Khalimov and others, 1983). Very large ozokerite deposits (one is more than 1 million metric tons) occur in Paleozoic rocks along the Sarykamysh fault on the south border of the Fergana basin (Taliyev, 1968).

Associated Information

As of the end of 1982 (?) the Fergana oil-gas province had yielded about 334 million barrels (45.2 million metric tons) of oil and condensate and about 706 billion cubic feet (20.0 billion cubic meters) of gas (Dikenshteyn, 1983). Zhabrev (1983) presented a partial listing of cumulative natural gas production and reserves for 17 major gas-producing fields in the province. As of the end of 1979, totals from this partial listing equate to about 477 billion cubic feet (13.5 billion cubic meters) for cumulative gas production and about 509 billion cubic feet (14.4 billion cubic meters) in Proved plus Probable gas reserves ($A+B+C_1$ in the Soviet classification).

The general impression reached during review of available petroleum information for this province is one of an extensive, deep intermontane basin containing relatively small discovered fields with structural traps. Most of these fields consist of multiple, stacked reservoirs. The basin has not been thoroughly explored by the drill; small discoveries continue intermittently, even along the basin flanks. Only scant exploratory drilling has been done in the central, deep part of the basin. The potential of the deep Tertiary (Paleogene-Neogene) section was made obvious by the large oil blowout in the Mingbulak field, in 1992, as described in previous report sections.

3. Future Basin Assessments for the Former Soviet Union

The portions of this Fergana basin report dealing with discovered fields represent a trial of collected data and of their analysis. For example, field-level oil production histories either were not available or were too sporadic for anything but cursory review. The trial was to determine if limited reported data from the (then) Soviet Union could be used to prepare reasonable reservoir engineering analyses, and this was done. Rather than using only general estimates of quantities, comprehensive reservoir parameter data were developed for calculating quantities of ultimately recoverable oil and gas and then aggregating them to field-level and basin-level results. Derivations from piecemeal reported data were required to provide suites of sufficient data for calculations. Both systematic and judgmental engineering estimates were performed to complete the non-reported portions of reservoir-level data.

The Fergana basin results required data processing and analyses beyond that anticipated. However, with subsequent availability and better coverage of input data, such reservoir-level studies are feasible for future basin assessments. For assessments of other, larger geologic basins of the former Soviet Union, more reservoir-level data are now commercially available in organized form, and could be purchased for any additional FESAP studies at the degree of detail presented here. The purchase of less detailed field-level data is an option and some field-level data have recently been acquired by EIA and the USGS. With limited allocation of agency resources, it is doubtful if basin assessments in the foreseeable future would be made at the reservoir-level detail of this report.

If basin-level studies of the former Soviet Union are continued, the vast Western Siberia basin would be the preferred next candidate. Oil and gas exported from Western Siberia have influence in world markets. For any such future assessment studies, geological and engineering judgments would continue to be the most important requirement of the process.

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Appendix A

Tabulation of Main Data

(English units)

Appendix A

Tabulation of Main Data

(English units)

Following is a list of main data tables, with abbreviated titles, in Appendix A. English units are presented here; metric units for the same parameters are presented in Appendix E. The available computer diskette also contains these tables as separate files.

Table A1. Basic Information and Estimates, by Reservoir for Fields Discovered Through 1987, Fergana Basin (English units)

Republic	Uz Blk	Field Name	Pay Zone Identification	Petro-leum Type	Formation Name	Field Dis-covery Year	Depth (ft)	Lith-ology Type	Drive Type
North Basin Flank									
Kyrgyzstan		Bedresay	L. Cret. XVIIIr	G	Layakan	1987?	9843	ms	gd?
Kyrgyzstan		Izbaskent	Olig. II (III)	O	Sumsar	1972	6440	ps	sg
Kyrgyzstan		Izbaskent	Eoc. V-VII	O	Turkestan-Alay	1972	7218	pc	sg
Kyrgyzstan		Izbaskent	Paleoc. IX	O	Bukhara	1972	7802	ps	sg
Kyrgyzstan		Izbaskent	Paleoc. X	O	Bukhara	1972	7874	ms	sg
Kyrgyzstan		Izbaskent	U. Cret. XII	G	Pestrotsvet	1972	8202	ms	gd
Kyrgyzstan		Izbaskent	U. Cret. XIII	G	Pestrotsvet	1972	8330	ps	gd
Kyrgyzstan		Izbaskent	U. Cret. XIV	G	Pestrotsvet	1972	9639	ms	gd
Kyrgyzstan		Izbaskent	U. Cret. XV	G	Pestrotsvet	1972	10013	ms	gd
Kyrgyzstan		Izbaskent	L. Cret. XVIII	G	Layakan	1972	10499	ms	gd
Uzbekistan	1	Kassansay	Olig. II (III)	O	Sumsar	1986?	5577	ms	wd?
Kyrgyzstan		Kyzyl-Alma	Jura. XXIII	G	--	1966	9022	ms	gd?
Kyrgyzstan		Maylisay	Eoc. V	O	Turkestan	1901	1640	tc	wd?
Kyrgyzstan		Maylisu III	Olig. II (III)	O	Sumsar	1962	2133	ms	sg+wf
Kyrgyzstan		Maylisu III	Eoc. V	O	Turkestan	1962	2297	ms	sg+wf
Kyrgyzstan		Maylisu III	Eoc. VII	O	Alay	1962	2379	mc	sg+wf
Kyrgyzstan		Maylisu III	U. Cret. XIII	G	Pestrotsvet	1962	2657	ps	gd
Kyrgyzstan		Maylisu III	U. Cret. XVII	G	Ustritsa	1962	4012	pc	gd
Kyrgyzstan		Maylisu III	L. Cret. XVIIIa	G	Kyzyl-Pilyal	1962	4101	ps	gd
Kyrgyzstan		Maylisu III	Jura. XXIII	G	--	1962	6135	ps	gd
Kyrgyzstan		Maylisu IV-Izbaskent, Vost. (E)	Mioc. kkp	O	Massaget	1948	3822	ms	sg+wf
Kyrgyzstan		Maylisu IV-Izbaskent, Vost. (E)	Olig. II (III)	O	Sumsar	1948	3937	ts	sg
Kyrgyzstan		Maylisu IV-Izbaskent, Vost. (E)	Eoc. V	O	Turkestan	1948	4101	ts	sg
Kyrgyzstan		Maylisu IV-Izbaskent, Vost. (E)	Eoc. VIIa	O	Alay	1948	4183	ts	sg
Kyrgyzstan		Maylisu IV-Izbaskent, Vost. (E)	Paleoc. IX	O	Bukhara	1948	4265	ms	sg
Kyrgyzstan		Maylisu IV-Izbaskent, Vost. (E)	U. Cret. XIII	GO	Pestrotsvet	1948	4462	ps	sg+wf
Kyrgyzstan		Maylisu IV-Izbaskent, Vost. (E)	U. Cret. XIV	GO	Pesrotsvet	1948	4692	ps	sg+wf
Kyrgyzstan		Maylisu IV-Izbaskent, Vost. (E)	U. Cret. XV	G	Yalovach	1948	5249	ps	gd
Kyrgyzstan		Maylisu IV-Izbaskent, Vost. (E)	U. Cret. XVI	G	Ustritsa	1948	5384	ms	gd
Kyrgyzstan		Maylisu IV-Izbaskent, Vost. (E)	U. Cret. XVII	G	Ustritsa	1948	5640	ps	gd
Kyrgyzstan		Maylisu IV-Izbaskent, Vost. (E)	L. Cret. XVIII	GC	Lyakan	1948	6070	ps	gd
Kyrgyzstan		Maylisu IV-Izbaskent, Vost. (E)	L. Cret. XIX	G	Muyan	1948	6562	ms	gd
Kyrgyzstan		Maylisu IV-Izbaskent, Vost. (E)	L. Cret. XXII	G	Muyan	1948	7218	ms	gd
Kyrgyzstan		Maylisu IV-Izbaskent, Vost. (E)	Jura. XXIII	G	--	1948	7480	ps	gd
Uzbekistan	1	Namangan	Eoc. V	O	Turkestan	1959	11647	mc	gd?
Uzbekistan	1	Shorbulak	Eoc. V	O	Turkestan	1973	12631	tc	wd?
Uzbekistan	1	Tergachi	Mioc. kkp	O	Massaget	1978	10827	ms	wd?
Uzbekistan	1	Tergachi	Eoc. V	O	Turkestan	1978	14108	tc	wd?
South Flank - NE of Fergana									
Uzbekistan	5	Alamyshik, Sever. (N)	Olig. II (III)	O	Sumsar	1973	8038	ms	sg
Uzbekistan	5	Alamyshik, Yuzh. (S)	Plioc. I+Ia	O	Baktria	1945	1444	pc	sg+wf
Uzbekistan	5	Alamyshik, Yuzh. (S)	Plioc. Ib	O	Baktria (?)	1945	1476	ps	sg+wf
Uzbekistan	5	Alamyshik, Yuzh. (S)	Mioc. Ic	O	Massaget	1945	1772	ms	sg+wf
Uzbekistan	5	Alamyshik, Yuzh. (S)	Olig. II (III)	O	Sumsar	1945	1804	ms	sg+wf
Uzbekistan	5	Alamyshik, Yuzh. (S)	Eoc. V-VII	O	Turkestan-Alay	1945	1952	mc	sg+wf
Uzbekistan	5	Alamyshik, Yuzh. (S)	L. Cret. XVIII	O	Kyzyl-Pilyal	1945	3609	ms	sg
Uzbekistan	5	Alamyshik, Yuzh. (S)	L. Cret. XIX-XXII	O	Muyan	1945	4462	ms	sg
Uzbekistan	5	Alamyshik, Yuzh. (S)	Jura. XXIII	GO	--	1945	5249	ps	sg
Uzbekistan	5	Andizhan	Plioc. I	GO	Massaget	1935	1089	ps	sg
Uzbekistan	5	Andizhan	Olig. III	GO	Sumsar	1935	2083	ms	gc
Uzbekistan	5	Andizhan	Eoc. V	GO	Turkestan	1935	2395	pc	sg+gc
Uzbekistan	5	Andizhan	Eoc. VI	GO	Turkestan	1935	2625	pc	sg+gc
Uzbekistan	5	Andizhan	Eoc. VII	GO	Alay	1935	2953	pc	sg+gc
Uzbekistan	5	Andizhan	Paleoc. VIII	G	Bukhara	1935	3117	pc	gd?
Uzbekistan	5	Boston	Plioc. I	O	Baktria	1952	1148	ms	sg+wf
Uzbekistan	5	Boston	Mioc. Ia	O	Massaget	1952	1312	ms	sg+wf
Uzbekistan	5	Boston	Mioc. I	O	Massaget	1952	1558	ms	sg+wf

Republic	Uz Blk	Field Name	Pay Zone Identification	Petro-leum Type	Formation Name	Field Dis-covery Year	Depth (ft)	Lith-ology Type	Drive Type
Uzbekistan	5	Boston	Olig. II (III)	O	Sumsar	1952	1706	ms	sg+wf
Uzbekistan	5	Boston	Olig. III	O	Sumsar	1952	2297	ms	sg+wf
Uzbekistan	5	Boston	L. Cret. XIX	G	Muyan	1952	6562	ms	gd?
Uzbekistan	5	Boston	L. Cret. XX+XXI+XXII	GO	Muyan	1952	6890	ms	sg?
Uzbekistan	5	Boston	Jura. XXVII	G	--	1952	7874	ms	gd?
Uzbekistan	5	Boston	Permo-Trias. XXX	O	--	1952	8858	ts	sg?
Kyrgyzstan		Changyrtash	Olig. III	O	Sumsar	1932	1608	ms	sg+wf
Kyrgyzstan		Changyrtash	Eoc. V	O	Turkestan	1932	1804	mc	sg+wf
Kyrgyzstan		Chigirchik	Jura. XXIII	O	--	1976	3281	ms	wd?
Uzbekistan	5	Khartum	Olig. III	O	Sumsar	1957	7093	ms	sg
Uzbekistan	5	Khartum	Eoc. VI	O	Turkestan	1957	8202	tc	wd+gd?
Uzbekistan	5	Khartum	Eoc. VII	G	Alay	1957	8366	mc	gd?
Uzbekistan	5	Khartum	L. Cret. XXII	GO	Muyan	1957	13451	ts	sg?
Uzbekistan	5	Khartum, Vost. (E)	Olig. II-III	O	Sumsar	1984	6562	ms	wd+gd
Uzbekistan	5	Khartum. Vost. (E)	Eoc. VI	G	Turkestan	1984	7283	mc	wd+gd
Uzbekistan	5	Khodzhaosman	L. Cret. XVIII	O	Lyakan	1956	1886	ms	sg
Uzbekistan	2	Palvantash	Plioc. I + Olig. III	O	Baktria + Sumsar	1943	1148	ts	wd
Uzbekistan	2	Palvantash	Eoc. IV-VI	GO	Khanabad-Turkestan	1943	1919	ms	wd+gd
Uzbekistan	2	Palvantash	Eoc. VII-VIII	GO	Alay-Bukhara	1943	2690	pc	wd+gd
Uzbekistan	2	Palvantash	U. Cret. XIII+XIV	G	Pestrotsvet	1943	3018	mc	wd+gd
Uzbekistan	2	Palvantash	L. Cret. XVIIIr	G	Lyakan	1943	5906	ms	wd+gd
Uzbekistan	2	Palvantash, Zap. (W)	Mioc. brp	O	Massaget	1955	4593	ms	wd
Uzbekistan	2	Palvantash, Zap. (W)	Olig. IIIb	O	Sumsar	1955	6234	ms	wd
Uzbekistan	2	Palvantash, Zap. (W)	Eoc. V+VI	O	Turkestan	1955	7119	ms	wd
Uzbekistan	2	Palvantash, Zap. (W)	Eoc. VII	O	Alay	1955	7218	pc	wd
Uzbekistan	2	Palvantash, Zap. (W)	Eoc. VIII-IX	O	Bukhara	1955	7776	mc	wd
Uzbekistan	5	Sharikhan-Khodzhiabad	Olig. II-III	O	Sumsar	1948	1706	ms	sg+wf
Uzbekistan	5	Sharikhan-Khodzhiabad	Eoc. V	O	Turkestan	1948	2149	pc	sg+wd
Uzbekistan	5	Sharikhan-Khodzhiabad	Eoc. VI	G	Turkestan	1948	2264	pc	gd
Uzbekistan	5	Sharikhan-Khodzhiabad	Eoc. VII	O	Alay	1948	2428	pc	sg+wd
Uzbekistan	5	Sharikhan-Khodzhiabad	Eoc. VIII	GO	Bukhara	1948	3445	mc	wd
Uzbekistan	5	Sharikhan-Khodzhiabad	L. Cret. XIX-XXII	GO	Muyan	1948	6234	ms	wd
Uzbekistan	5	Sharikhan-Khodzhiabad	Jura. XXIII-XXIX	GO	--	1948	7930	ts	wd
Kyrgyzstan		Suzak	L. Cret. XIX	G	Muyan	1969	6112	ms	gd?
Kyrgyzstan		Suzak	L. Cret. XXI	G	Muyan	1969	6234	ms	gd?
South Flank - SW of Fergana									
Uzbekistan?	4?	Aksaray	Eoc. VII	G	Alay	1985?	2510	mc	gd?
Uzbekistan?	4?	Aksaray	Paleoc. VIII	G	Bukhara	1985?	3363	mc	gd?
Uzbekistan	3	Avval'	Eoc. V	O	Turkestan	1955	2953	ms	wd?
Uzbekistan	3	Avval', Vost. (E)	Eoc. V	O	Turkestan	1954	3609	mc	wd?
Tadzhikistan		Ayritan	Olig. II (III)	GO	Sumsar	1967	4101	ts	sg?
Tadzhikistan		Ayritan	Eoc. V	O	Turkestan	1967	4396	tc	sg?
Tadzhikistan		Ayritan	Eoc. VII	O	Alay	1967	4708	mc	sg+wf
Tadzhikistan		Ayritan	Paleoc. IX	G	Bukhara	1967	5167	ms	gd?
Kyrgyzstan		Beshkent-Togap	Olig. II (III)	O	Sumsar	1976	5249	ms	sg+wf
Uzbek/Kyrgyz	3p	Chaur-Yarkutan-Chimion	Eoc. IV	O	Khanabad	1904	984	ms	sg+wf
Uzbek/Kyrgyz	3p	Chaur-Yarkutan-Chimion	Eoc. V, VI	O	Turkestan	1904	1148	ms	sg+wf
Uzbek/Kyrgyz	4p	Chongara-Gal'cha	Eoc. IV	GO	Khanabad	1949	1312	ps	sg+gc
Uzbek/Kyrgyz	4p	Chongara-Gal'cha	Eoc. V	G	Turkestan	1949	1378	pc	gd
Uzbek/Kyrgyz	4p	Chongara-Gal'cha	Eoc. VII	G	Alay	1949	1509	mc	gd
Tadzhikistan		Karagachi-Tamchi	Eoc. IV	O	Khanabad	1974	8054	ps	sg?
Uzbekistan	3	Khankyz	Olig. II (III)	O	Sumsar	1957	4462	ts	wd
Uzbekistan	3	Khankyz	Eoc. VII	O	Alay	1957	5577	ms	wd
Uzbekistan	3	Khankyz	L. Cret. XVIII	G	Kalachin(?)-Kyzyl-Pilyal	1957	8120	ms	gd
Tadzhikistan		Kim (Sel'rokho)	Olig. II (III)	O	Sumsar	1908	1969	ps	sg+wf
Tadzhikistan		Kim (Sel'rokho)	Eoc. V	O	Turkestan	1908	2034	mc	sg+wf
Tadzhikistan		Kim (Sel'rokho)	Eoc. VI	O	Turkestan	1908	2100	ms	sg+wf
Tadzhikistan		Kim (Sel'rokho)	Eoc. VIa	O	Turkestan	1908	2133	ms	sg+wf
Tadzhikistan		Kim (Sel'rokho)	Eoc. VII	O	Alay	1908	2198	mc	sg+wf

Republic	Uz Blk	Field Name	Pay Zone Identification	Petro-leum Type	Formation Name	Field Dis-covery Year	Depth (ft)	Lith-ology Type	Drive Type
Tadzhikistan		Nefteabad	Olig. II (III)	GO	Sumsar	1933	3478	ts	sg?
Uzbekistan?	3?	Obi-Shifo	Olig. II-III	O	Sumsar	1982?	2297	ms	sg+wf
Kyrgyzstan		Rishtan, Sever. (N)	U. Cret. XIV	G	Pestrotsvet	1954	1886	ps	gd?
Kyrgyzstan		Rishtan, Sever. (N)	U. Cret. XVI + XVII	O	Ustritsa	1954	2372	ms	sg+wf
Kyrgyzstan		Rishtan, Sever. (N)	L. Cret. XVIIIr	G	Lyakan	1954	3117	pc	gd?
Kyrgyzstan		Rishtan, Sever. (N)	Jura. XXIII-XXIX	G	--	1954	4101	ms	gd?
Kyrgyzstan		Sarykamysh	U. Cret. XIV	G	Pestrotsvet	1955	1033	ms	gd?
Kyrgyzstan		Sarykamysh	L. Cret. XVIIr	G	Lyakan	1955	2133	mc	gd?
Kyrgyzstan		Sarykamysh	Jura. XXIII	G	--	1955	3281	ms	gd?
Kyrgyzstan		Sarytok	Jura. XXVI	G	--	1963	3773	ms	gd?
Uzbekistan	4	Shorsu IV	Olig. II (III)	O	Sumsar	1927	984	ms	sg+wf
Uzbekistan	4	Shorsu IV	Eoc. IV	O	Khanabad	1927	1066	ps	sg+wf
Uzbekistan	4	Shorsu IV	Eoc. V	OG	Turkestan	1927	1148	pc	sg?
Uzbekistan	4	Shorsu IV	Eoc. VI	O	Turkestan	1927	1312	ms	sg+wf
Uzbekistan	4	Shorsu IV	Eoc. VII	O	Alay	1927	1378	mc	sg+wf
Uzbekistan	4	Shorsu IV	Paleoc. VIII	O	Bukhara	1927	1476	mc	sg+wf
Uzbekistan	4	Shorsu IV	Paleoc. IX	O	Bukhara	1927	1640	ms	sg+wf
Uzbekistan	4	Shorsu VI	Eoc. VII	G	Alay	1986?	1050	mc	gd?
Uzbekistan	4	Sokh, Sever. (N)	Olig. II	OG	Sumsar	1956	3510	ms	sg
Uzbekistan	4	Sokh, Sever. (N)	Eoc. IV	GO	Khanabad	1956	4265	mc	sg+wf
Uzbekistan	4	Sokh, Sever. (N)	Eoc. V	GC	Turkestan	1956	4429	mc	gd
Uzbekistan	4	Sokh, Sever. (N)	Eoc. VII	G	Alay	1956	4593	mc	sg
Uzbekistan	4	Sokh, Sever. (N)	Paleoc. VIII	O	Bukhara	1956	4921	mc	sg+wf
Uzbekistan	4	Sokh, Sever. (N)	U. Cret. XIV-XV	GO	Pestrotsvet	1956	5348	ts	gd
Uzbekistan	4	Sokh, Sever. (N)	L. Cret. XVIIIr	GC	Lyakan	1956	5906	ps	gd
Uzbekistan	4	Sokh, Sever. (N)	L. Cret. XXII	GC	Muyan	1956	6234	ms	gd
Uzbekistan	4	Sokh, Sever. (N)	Jura. XXIV-XXV	GC	--	1956	6890	ms	gd
Uzbekistan	4	Tasravet	Eoc. IV	O	Khanabad	1983?	2625	ms	sg+wf
Central Basin Graben									
Uzbekistan	4	Achisu	Olig. II (III)	O	Sumsar	1979	11483	ms	sg?
Uzbekistan	2	Gumkhana	Plioc. I	O	Baktria	1976	14108	ms	sg?
Uzbekistan	2	Gumkhana	Mioc.(?)	O	Massaget(?)	1976	15420	ms	sg?
Tadzhikistan		Kanibadam	Eoc. V	O	Turkestan	1966	9777	mc	sg
Tadzhikistan		Kanibadam	Eoc. VII	O	Alay	1966	9843	mc	sg
Tadzhikistan		Kanibadam	Paleoc. IX+IXa	GC	Bukhara	1966	10308	ps	gd
Tadzhikistan		Kanibadam, Sever. (N)	Olig. II (III)	O	Sumsar	1970	9596	ms	sg
Tadzhikistan		Madaniyat	Olig. II	O	Sumsar	1978	12467	ms	sg?
Tadzhikistan		Madaniyat	Eoc. IV	O	Khanabad	1978	12598	ms	sg?
Tadzhikistan		Madaniyat	Eoc. VII	O	Alay	1978	12730	ms	sg?
Uzbekistan?	4?	Makhram	Olig. II-III	O	Sumsar	1985?	11483	ms	sg?
Uzbekistan		Mingbulak	Mioc. kkp	O	Massaget	1983*	17208	ms	?
Uzbekistan		Mingbulak	Olig. III	O	Sumsar	1983*	18340	ms	?
Uzbekistan		Mingbulak	Paleoc. VIII	O	Bukhara	1983*	19226	mc	?
Uzbekistan		Mingbulak	Paleoc. IX	GC	Bukhara	1983*	19354	ms	?
Tadzhikistan		Niyazbek-Karakchikum	Olig. II (III)	O	Sumsar	1974	12303	ms	sg
Tadzhikistan		Niyazbek-Karakchikum	Eoc. IV	O	Khanabad	1974	12434	ms	sg
Tadzhikistan		Niyazbek-Karakchikum	Eoc. V	O	Turkestan	1974	12467	mc	sg
Tadzhikistan		Niyazbek-Karakchikum	Eoc. VI	GC	Turkestan	1974	12500	mc	gd
Tadzhikistan		Niyazbek-Karakchikum	Eoc. VIIa	GC	Alay	1974	12566	ms	gd
Tadzhikistan		Niyazbek-Karakchikum	Paleoc. IX	GC	Bukhara	1974	12631	ms	gd
Tadzhikistan		Niyazbek-Karakchikum	U. Cret. XI-XII	GC	Pestrotsvet	1974	12795	ms	gd
Tadzhikistan		Ravat	Olig. II (III)	O	Sumsar	1961	10335	ms	wd
Tadzhikistan		Ravat	Eoc. IV	O	Khanabad	1961	10745	tc	wd
Tadzhikistan		Ravat	Eoc. V	GC	Turkestan	1961	10794	mc	wd
Tadzhikistan		Ravat	Eoc. VII	O	Alay	1961	11319	mc	wd
Tadzhikistan		Ravat	Paleoc. IX-IXa	GC	Bukhara	1961	11647	ms	wd
Uzbekistan	4	Varyk	Olig. II (III)	O	Sumsar	1971	10499	ms	sg?
Uzbekistan	4	Varyk	Eoc. IV	O	Khanabad	1971	11483	ms	sg?
Uzbekistan	4	Varyk	Eoc. V	G	Turkestan	1971	11647	mc	gd?

Table A1. Basic Information and Estimates, by Reservoir for Fields Discovered Through 1987, Fergana Basin (English units) Continued

Republic	Uz Blk	Field Name	Pay Zone Identification	Petroleum Type	Formation Name	Field Discovery Year	Depth (ft)	Lithology Type	Drive Type
Uzbekistan	4	Varyk	Eoc. VII	O	Alay	1971	12165	mc	sg?
Uzbekistan	4	Varyk	Paleoc. IX	O	Bukhara	1971	12467	ms	sg?
Uzbekistan	4	Varyk II	Olig. II (III)	O	Sumsar	1978	14764	ps	sg?
Uzbekistan	4	Varyk II	Eoc. IV	O	Khanabad	1978	16601	ts	sg?
Uzbekistan	4	Varyk II	Eoc. VII	O	Alay	1978	16732	tc	sg?
Total		**53 fields and**	**177**	**121 O-GO-OG**					
3 republics		**field-combinations**	**reservoirs**	**56 G-GC**					
				type reservoirs					

Notes: At least 7 additional fields exist (1993 Uzbek & Petroconsultants information), which were probably discovered after 1987.

Available data do not provide accurate field locations. However, fields were assigned to republic areas, and further, to Uzbek license blocks offered on August 25, 1993 (Uz Blk).

3p and 4p indicate field combinations that cross republic borders, with parts in Uzbek blocks 3 and 4.

Volumetric calculations used piecemeal data sources and estimates. Some of the most sensitive data to calculations (reservoir area and thickness), were the least reliable.

Listing of fields in the central basin graben is from Glumakov, et al, 1988; not all are deep-basin.

Initial field discovery year used for all reservoirs in that field.

For Mingbulak field, data listed with 1983* (asterisk) discovery year relate to estimates following the 1992 oil blowout.

Totals may not equal sum of components due to independent rounding. Other calculations also use complete values rather than the rounded values listed.

N-E-S-W as directions of north, east, south, and west.

? = particularly questionable.

Pay Zones as Plioc., Mioc., Olig., Eoc., Paleoc. are epochs of Tertiary Period (Pliocene, Miocene, Oligocene, Eocene, Paleocene). U. and L. Cret. are Upper and Lower Cretaceous Epochs. Jura. is Jurassic Period and Permo-Trias. is a composite zone of the Permian-Triassic Periods.

Petroleum Type as that in the reservoir; O = oil, G = natural gas, GC = gas condensate; when GO or OG is listed, the last letter indicates dominance.

Units as ft = feet.

Lithology Type as ts-ms-ps indicate sandstones in categories of tight-medium-more permeable, with separations at 10 and 600 millidarcies; tc-mc-pc indicate carbonates with the same permeability categories.

Drive Type as reservoir fluid energy, with wd = water drive; sg = solution gas drive; gc = gas cap drive; gd = gas depletion drive; wf = water-flood for improved recovery.

Source: Energy Information Administration, Office of Oil and Gas.

Table A2. Fluid Volumetric Estimates, by Reservoir for Fields Discovered through 1987, Fergana Basin (English Units)

Field Name	Pay Zone Identification	Petro-leum Type	Original Oil In Place (MMstb)	Total Ultimate Recoverable Oil, Primary + Waterflood (MMstb)	Total Ultimate Recoverable A-D Gas, Pri. + Wf. (MMscf)	Original NA Gas In Place (MMscf)	Ultimate Recoverable NA Gas (MMscf)
North Basin Flank							
Bedresay	L. Cret. XVIIIg	G	--	--	--	42627.481	31118.061
Izbaskent	Olig. II (III)	O	7.662	1.303	443.041	--	--
Izbaskent	Eoc. V-VII	O	11.965	0.957	376.799	--	--
Izbaskent	Paleoc. IX	O	9.809	1.766	663.156	--	--
Izbaskent	Paleoc. X	O	9.773	1.857	715.260	--	--
Izbaskent	U. Cret. XII	G	--	--	--	23258.056	17908.703
Izbaskent	U. Cret. XIII	G	--	--	--	83190.667	62393.000
Izbaskent	U. Cret. XIV	G	--	--	--	22113.551	16142.892
Izbaskent	U. Cret. XV	G	--	--	--	29845.571	21488.811
Izbaskent	L. Cret. XVIII	G	--	--	--	35772.500	25398.475
Kassansay	Olig. II (III)	O	14.867	8.177	4541.610	--	--
Kyzyl-Alma	Jura. XXIII	G	--	--	--	54925.761	40645.063
Maylisay	Eoc. V	O	6.073	1.943	359.930	--	--
Maylisu III	Olig. II (III)	O	13.213	3.303	1754.868	--	--
Maylisu III	Eoc. V	O	7.741	1.935	1207.754	--	--
Maylisu III	Eoc. VII	O	12.047	1.205	751.822	--	--
Maylisu III	U. Cret. XIII	G	--	--	--	42854.416	35997.710
Maylisu III	U. Cret. XVII	G	--	--	--	29094.358	24439.261
Maylisu III	L. Cret. XVIIIa	G	--	--	--	30645.065	25741.855
Maylisu III	Jura. XXIII	G	--	--	--	71963.139	58290.143
Maylisu IV-Izbaskent, Vost. (E)	Mioc. kkr	O	117.396	25.827	5050.934	--	--
Maylisu IV-Izbaskent, Vost. (E)	Olig. II (III)	O	133.131	11.982	2431.112	--	--
Maylisu IV-Izbaskent, Vost. (E)	Eoc. V	O	45.941	4.594	1112.754	--	--
Maylisu IV-Izbaskent, Vost. (E)	Eoc. VIIa	O	37.800	3.780	1016.280	--	--
Maylisu IV-Izbaskent, Vost. (E)	Paleoc. IX	O	5.151	0.876	255.303	--	--
Maylisu IV-Izbaskent, Vost. (E)	U. Cret. XIII	GO	38.645	18.550	9712.287	--	--
Maylisu IV-Izbaskent, Vost. (E)	U. Cret. XIV	GO	10.505	3.257	1705.053	--	--
Maylisu IV-Izbaskent, Vost. (E)	U. Cret. XV	G	--	--	--	15293.175	12387.472
Maylisu IV-Izbaskent, Vost. (E)	U. Cret. XVI	G	--	--	--	17822.025	14257.620
Maylisu IV-Izbaskent, Vost. (E)	U. Cret. XVII	G	--	--	--	18997.070	15197.656
Maylisu IV-Izbaskent, Vost. (E)	L. Cret. XVIII	GC	--	--	--	37277.714	29822.171
Maylisu IV-Izbaskent, Vost. (E)	L. Cret. XIX	G	--	--	--	18550.134	15211.110
Maylisu IV-Izbaskent, Vost. (E)	L. Cret. XXII	G	--	--	--	15182.203	12145.763
Maylisu IV-Izbaskent, Vost. (E)	Jura. XXIII	G	--	--	--	65700.208	51903.164
Namangan	Eoc. V	O	14.284	1.857	1559.314	--	--
Shorbulak	Eoc. V	O	8.227	3.537	2936.317	--	--
Tergachi	Mioc. kkr	O	61.510	35.676	20306.243	--	--
Tergachi	Eoc. V	O	9.106	3.734	2479.299	--	--
South Flank - NE of Fergana							
Alamyshik, Sever. (N)	Olig. II (III)	O	49.678	10.432	4861.006	--	--
Alamyshik, Yuzh. (S)	Plioc. I+Ia	O	51.300	6.156	1721.055	--	--
Alamyshik, Yuzh. (S)	Plioc. Ib	O	46.809	14.043	3271.663	--	--
Alamyshik, Yuzh. (S)	Mioc. Ic	O	26.257	7.877	1725.080	--	--
Alamyshik, Yuzh. (S)	Olig. II (III)	O	26.363	7.909	1105.570	--	--
Alamyshik, Yuzh. (S)	Eoc. V-VII	O	17.805	2.315	301.993	--	--
Alamyshik, Yuzh. (S)	L. Cret. XVIII	O	22.330	4.913	899.741	--	--
Alamyshik, Yuzh. (S)	L. Cret. XIX-XXII	O	4.623	1.063	242.039	--	--
Alamyshik, Yuzh. (S)	Jura. XXIII	GO	2.383	0.548	173.690	--	--
Andizhan	Plioc. I	GO	13.872	2.219	539.198	--	--
Andizhan	Olig. III	GO	15.395	3.849	1939.996	--	--
Andizhan	Eoc. V	GO	3.895	0.312	215.560	--	--
Andizhan	Eoc. VI	GO	3.467	0.277	198.477	--	--
Andizhan	Eoc. VII	GO	6.318	0.505	420.483	--	--
Andizhan	Paleoc. VIII	G	--	--	--	5993.464	4435.164

Table A2. Fluid Volumetric Estimates, by Reservoir for Fields Discovered through 1987, Fergana Basin (English Units) Continued

Field Name	Pay Zone Identification	Petro-leum Type	Original Oil In Place (MMstb)	Total Ultimate Recoverable Oil, Primary + Waterflood (MMstb)	Total Ultimate Recoverable A-D Gas, Pri. + Wf. (MMscf)	Original NA Gas In Place (MMscf)	Ultimate Recoverable NA Gas (MMscf)
Boston	Plioc. I	O	26.885	6.721	353.624	--	--
Boston	Mioc. Ia	O	23.210	5.802	1110.148	--	--
Boston	Mioc. I	O	29.333	7.920	2613.846	--	--
Boston	Olig. II (III)	O	19.498	5.264	1008.386	--	--
Boston	Olig. III	O	12.548	3.388	973.435	--	--
Boston	L. Cret. XIX	G	--	--	--	11735.042	9153.333
Boston	L. Cret. XX+XXI+XXII	GO	6.148	1.291	711.219	--	--
Boston	Jura. XXVII	G	--	--	--	7790.260	6134.700
Boston	Permo-Trias. XXX	O	0.985	0.138	99.951	--	--
Changyrtash	Olig. III	O	46.350	11.588	3800.422	--	--
Changyrtash	Eoc. V	O	17.042	1.704	472.035	--	--
Chigirchik	Jura. XXIII	O	57.403	27.554	1996.118	--	--
Khartum	Olig. III	O	10.601	2.226	1082.881	--	--
Khartum	Eoc. VI	O	7.483	1.721	1194.445	--	--
Khartum	Eoc. VII	G	--	--	--	7361.834	5447.757
Khartum	L. Cret. XXII	GO	12.099	1.694	1533.624	--	--
Khartum, Vost. (E)	Olig. II-III	O	21.096	8.227	4192.581	--	--
Khartum. Vost. (E)	Eoc. VI	G	--	--	--	41512.675	33625.267
Khodzhaosman	L. Cret. XVIII	O	4.114	0.823	221.075	--	--
Palvantash	Plioc. I + Olig. III	O	4.564	1.552	37.935	--	--
Palvantash	Eoc. IV-VI	GO	34.676	10.403	349.566	--	--
Palvantash	Eoc. VII-VIII	GO	26.846	8.054	579.924	--	--
Palvantash	U. Cret. XIII+XIV	G	--	--	--	16645.554	14148.721
Palvantash	L. Cret. XVIIIg	G	--	--	--	958.625	757.314
Palvantash, Zap. (W)	Mioc. bgr	O	47.390	24.169	3265.876	--	--
Palvantash, Zap. (W)	Olig. IIIb	O	20.634	9.698	572.498	--	--
Palvantash, Zap. (W)	Eoc. V+VI	O	6.834	3.554	1363.689	--	--
Palvantash, Zap. (W)	Eoc. VII	O	5.510	1.929	474.396	--	--
Palvantash, Zap. (W)	Eoc. VIII-IX	O	4.773	2.005	788.919	--	--
Sharikhan-Khodzhiabad	Olig. II-III	O	39.834	9.959	2390.297	--	--
Sharikhan-Khodzhiabad	Eoc. V	O	9.772	0.879	205.697	--	--
Sharikhan-Khodzhiabad	Eoc. VI	G	--	--	--	7116.217	5621.811
Sharikhan-Khodzhiabad	Eoc. VII	O	115.007	10.351	2420.848	--	--
Sharikhan-Khodzhiabad	Eoc. VIII	GO	50.220	21.092	10125.257	--	--
Sharikhan-Khodzhiabad	L. Cret. XIX-XXII	GO	118.225	66.206	37073.799	--	--
Sharikhan-Khodzhiabad	Jura. XXIII-XXIX	GO	33.864	15.916	9420.306	--	--
Suzak	L. Cret. XIX	G	--	--	--	91219.557	71151.255
Suzak	L. Cret. XXI	G	--	--	--	122879.674	100761.332
South Flank - SW of Fergana							
Aksaray	Eoc. VII	G	--	--	--	6363.789	4963.755
Aksaray	Paleoc. VIII	G	--	--	--	4985.033	3788.625
Avval'	Eoc. V	O	13.276	6.505	1450.215	--	--
Avval', Vost. (E)	Eoc. V	O	5.491	2.197	419.216	--	--
Ayritan	Olig. II (III)	GO	4.660	0.280	58.528	--	--
Ayritan	Eoc. V	O	7.315	0.439	100.226	--	--
Ayritan	Eoc. VII	O	24.778	2.973	773.394	--	--
Ayritan	Paleoc. IX	G	--	--	--	16717.212	13039.425
Beshkent-Togap	Olig. II (III)	O	31.233	7.808	763.519	--	--
Chaur-Yarkutan-Chimion	Eoc. IV	O	30.137	6.630	484.231	--	--
Chaur-Yarkutan-Chimion	Eoc. V, VI	O	45.627	10.950	963.690	--	--
Chongara-Gal'cha	Eoc. IV	GO	153.822	33.841	34993.438	--	--
Chongara-Gal'cha	Eoc. V	G	--	--	--	17771.292	13861.608
Chongara-Gal'cha	Eoc. VII	G	--	--	--	49849.980	37885.985
Karagachi-Tamchi	Eoc. IV	O	184.615	53.538	33614.428	--	--
Khankyz	Olig. II (III)	O	11.266	3.605	178.440	--	--
Khankyz	Eoc. VII	O	36.188	13.751	672.824	--	--
Khankyz	L. Cret. XVIII	G	--	--	--	53813.299	40898.107

Table A2. Fluid Volumetric Estimates, by Reservoir for Fields Discovered through 1987, Fergana Basin (English Units) Continued

Field Name	Pay Zone Identification	Petro-leum Type	Original Oil In Place (MMstb)	Total Ultimate Recoverable Oil, Primary + Waterflood (MMstb)	Total Ultimate Recoverable A-D Gas, Pri. + Wf. (MMscf)	Original NA Gas In Place (MMscf)	Ultimate Recoverable NA Gas (MMscf)
Kim (Sel'rokho)	Olig. II (III)	O	65.520	16.380	3145.286	--	--
Kim (Sel'rokho)	Eoc. V	O	48.936	5.872	1392.668	--	--
Kim (Sel'rokho)	Eoc. VI	O	100.148	27.040	6669.279	--	--
Kim (Sel'rokho)	Eoc. VIa	O	55.329	14.939	3684.633	--	--
Kim (Sel'rokho)	Eoc. VII	O	114.140	13.697	3248.336	--	--
Nefteabad	Olig. II (III)	GO	35.361	3.536	725.483	--	--
Obi-Shifo	Olig. II-III	O	16.738	4.185	803.508	--	--
Rishtan, Sever. (N)	U. Cret. XIV	G	--	--	--	6875.236	5500.189
Rishtan, Sever. (N)	U. Cret. XVI + XVII	O	13.240	3.575	1023.347	--	--
Rishtan, Sever. (N)	L. Cret. XVIIIg	G	--	--	--	7791.277	6233.022
Rishtan, Sever. (N)	Jura. XXIII-XXIX	G	--	--	--	51480.362	41184.289
Sarykamysh	U. Cret. XIV	G	--	--	--	2951.294	2420.061
Sarykamysh	L. Cret. XVII	G	--	--	--	5219.221	4123.184
Sarykamysh	Jura. XXIII	G	--	--	--	23519.040	19285.613
Sarytok	Jura. XXVI	G	--	--	--	4590.124	3672.099
Shorsu IV	Olig. II (III)	O	11.093	2.773	401.821	--	--
Shorsu IV	Eoc. IV	O	5.979	1.495	287.040	--	--
Shorsu IV	Eoc. V	OG	4.306	0.344	73.957	--	--
Shorsu IV	Eoc. VI	O	5.947	1.606	321.772	--	--
Shorsu IV	Eoc. VII	O	20.277	2.028	391.716	--	--
Shorsu IV	Paleoc. VIII	O	5.594	0.559	122.318	--	--
Shorsu IV	Paleoc. IX	O	4.808	1.154	282.097	--	--
Shorsu VI	Eoc. VII	G	--	--	--	11653.766	8973.400
Sokh, Sever. (N)	Olig. II	OG	68.695	13.052	2677.828	--	--
Sokh, Sever. (N)	Eoc. IV	GO	12.763	1.659	316.656	--	--
Sokh, Sever. (N)	Eoc. V	GC	--	--	--	27341.817	21873.454
Sokh, Sever. (N)	Eoc. VII	G	--	--	--	38079.073	30463.258
Sokh, Sever. (N)	Paleoc. VIII	O	42.890	5.576	1322.331	--	--
Sokh, Sever. (N)	U. Cret. XIV-XV	GO	48.129	5.294	2496.278	--	--
Sokh, Sever. (N)	L. Cret. XVIIIg	GC	--	--	--	48566.760	37396.405
Sokh, Sever. (N)	L. Cret. XXII	GC	--	--	--	8228.139	6500.229
Sokh, Sever. (N)	Jura. XXIV-XXV	GC	--	--	--	48420.895	38252.507
Tasravet	Eoc. IV	O	10.611	2.865	810.499	--	--
Central Basin Graben							
Achisu	Olig. II (III)	O	17.258	3.452	1473.486	--	--
Gumkhana	Plioc. I	O	37.597	6.016	6015.595	--	--
Gumkhana	Mioc.(?)	O	97.779	13.917	15308.599	--	--
Kanibadam	Eoc. V	O	5.795	0.464	198.238	--	--
Kanibadam	Eoc. VII	O	16.810	1.513	654.231	--	--
Kanibadam	Paleoc. IX+IXa	GC	--	--	--	53817.954	38748.927
Kanibadam, Sever. (N)	Olig. II (III)	O	12.835	2.695	1356.390	--	--
Madaniyat	Olig. II	O	16.188	3.238	1407.310	--	--
Madaniyat	Eoc. IV	O	16.449	3.125	1433.911	--	--
Madaniyat	Eoc. VII	O	49.152	9.637	4188.780	--	--
Makhram	Olig. II-III	O	9.553	1.911	906.278	--	--
Mingbulak	Mioc. kkp	O	693.943	111.031	145672.450	--	--
Mingbulak	Olig. III	O	199.771	31.963	50122.942	--	--
Mingbulak	Paleoc. VIII	O	136.717	21.875	34302.557	--	--
Mingbulak	Paleoc. IX	GC	--	--	--	520987.820	343851.961
Niyazbek-Karakchikum	Olig. II (III)	O	47.769	9.554	5075.580	--	--
Niyazbek-Karakchikum	Eoc. IV	O	33.935	6.787	3933.416	--	--
Niyazbek-Karakchikum	Eoc. V	O	22.094	2.209	1280.507	--	--
Niyazbek-Karakchikum	Eoc. VI	GC	--	--	--	53298.160	37841.694
Niyazbek-Karakchikum	Eoc. VIIa	GC	--	--	--	154709.116	106749.290
Niyazbek-Karakchikum	Paleoc. IX	GC	--	--	--	82687.758	57054.553
Niyazbek-Karakchikum	U. Cret. XI-XII	GC	--	--	--	64026.673	44178.404
Ravat	Olig. II (III)	O	18.265	10.776	17567.332	--	--

Table A2. Fluid Volumetric Estimates, by Reservoir for Fields Discovered through 1987, Fergana Basin (English Units) Continued

Field Name	Pay Zone Identification	Petro-leum Type	Original Oil In Place (MMstb)	Total Ultimate Recoverable Oil, Primary + Waterflood (MMstb)	Total Ultimate Recoverable A-D Gas, Pri. + Wf. (MMscf)	Original NA Gas In Place (MMscf)	Ultimate Recoverable NA Gas (MMscf)
Ravat	Eoc. IV	O	22.893	7.555	1308.820	--	--
Ravat	Eoc. V	GC	--	--	--	12057.674	8560.949
Ravat	Eoc. VII	O	10.388	4.467	3127.328	--	--
Ravat	Paleoc. IX-IXa	GC	--	--	--	29054.858	20919.498
Varyk	Olig. II (III)	O	28.241	5.931	3022.101	--	--
Varyk	Eoc. IV	O	15.060	2.861	2028.518	--	--
Varyk	Eoc. V	G	--	--	--	29707.531	20498.196
Varyk	Eoc. VII	O	40.240	3.622	2456.187	--	--
Varyk	Paleoc. IX	O	37.889	7.199	4923.165	--	--
Varyk II	Olig. II (III)	O	11.011	2.533	1691.338	--	--
Varyk II	Eoc. IV	O	8.000	1.120	796.907	--	--
Varyk II	Eoc. VII	O	19.864	1.788	1271.940	--	--
Total 53 fields and field-combinations	177 reservoirs	121 O-GO-OG & 56 G-GC reservoirs	4542.698 MMstb OOIP	1017.743 MMstb Rec. Oil	583620.396 MMscf A-D Gas	2402891.149 MMscf OGIP (NA)	1780444.272 MMscf NA Rec. Gas

Notes: At least 7 additional fields exist (1993 Uzbek & Petroconsultants information), which were probably discovered after 1987.

Volumetric calculations used piecemeal data sources and estimates. Some of the most sensitive data to calculations (reservoir area and thickness), were the least reliable.

Listing of fields in the central basin graben is from Glumakov, et al, 1988; not all are deep-basin.

Initial field discovery year used for all reservoirs in that field.

For Mingbulak field, data listed with 1983* (asterisk) discovery year relate to estimates following the 1992 oil blowout.

Totals may not equal sum of components due to independent rounding. Other calculations also use complete values rather than the rounded values shown.

N-E-S-W as directions of north, east, south, and west.

Pay Zones as Plioc., Mioc., Olig., Eoc., Paleoc. are epochs of Tertiary Period (Pliocene, Miocene, Oligocene, Eocene, Paleocene). U. an L. Cret. are Upper and Lower Cretaceous Epochs. Jura. is Jurassic Period and Permo-Trias. is a composite zone of the Permian-Triassic Periods.

Petroleum Type as that in the reservoir; O = oil, G = natural gas, GC = gas condensate; when GO or OG is listed, the last letter indicates dominance.

Units as MMstb = million stock tank barrels oil; MMscf = million standard cubic feet gas. These units represent surface conditions.

Primary (Pri.) = oil recovery mechanism, including liquid expansion; Waterflood (Wf.) = improved oil recovery by waterflood; A-D Gas = associated-and/or-dissolved gas in oil reservoirs or produced with the oil; NA Gas = nonassociated (free) gas; OOIP = original oil in place; OGIP = original NA gas in place.

Source: Energy Information Administration, Office of Oil and Gas.

Table A3. Reservoir Parameter Estimates, by Reservoir for Fields Discovered through 1987, Fergana Basin (English Units)

Field Name	Pay Zone Identification	Petroleum Type	Reservoir Area (acres)	Net Pay Thickness (ft)	Porosity (frac)	Water Saturation (frac)	Initial Reservoir Pressure (psi)	Gas Reservoir Abandon. Pressure (psi)	Initial Reservoir Temperature (deg F)	Converted Permeability (md)
North Basin Flank										
Bedresay	L. Cret. XVIIIr	G	1204.6	39.4	0.100	0.25	4820	984	176	
Izbaskent	Olig. II (III)	O	1478.9	6.6	0.180	0.34	4434	--	113	304
Izbaskent	Eoc. V-VII	O	2300.6	6.6	0.180	0.32	4253	--	135	608
Izbaskent	Paleoc. IX	O	2300.6	6.6	0.150	0.33	4351	--	156	339
Izbaskent	Paleoc. X	O	2300.6	6.6	0.150	0.33	4395	--	156	
Izbaskent	U. Cret. XII	G	968.7	19.7	0.160	0.35	4395	820	160	
Izbaskent	U. Cret. XIII	G	968.7	49.2	0.250	0.36	4076	833	161	1038
Izbaskent	U. Cret. XIV	G	968.7	19.7	0.150	0.33	4511	964	174	
Izbaskent	U. Cret. XV	G	968.7	26.2	0.150	0.33	4656	1001	178	
Izbaskent	L. Cret. XVIII	G	518.9	78.7	0.100	0.25	4728	1050	183	
Kassansay	Olig. II (III)	O	1204.6	19.7	0.160	0.35	2815	--	133	
Kyzyl-Alma	Jura. XXIII	G	803.1	75.5	0.110	0.27	4271	902	168	51
Maylisay	Eoc. V	O	963.7	12.1	0.120	0.39	595	--	77	4
Maylisu III	Olig. II (III)	O	1445.6	14.8	0.160	0.35	941	--	98	
Maylisu III	Eoc. V	O	1445.6	12.1	0.100	0.25	1030	--	100	
Maylisu III	Eoc. VII	O	1445.6	17.1	0.120	0.29	1075	--	101	
Maylisu III	U. Cret. XIII	G	1445.6	55.8	0.146	0.27	1465	266	104	608
Maylisu III	U. Cret. XVII	G	1445.6	23.0	0.158	0.30	2335	401	118	
Maylisu III	L. Cret. XVIIIa	G	1445.6	23.0	0.150	0.28	2530	410	118	608
Maylisu III	Jura. XXIII	G	1445.6	39.4	0.180	0.35	3613	614	139	172
Maylisu IV-Izbaskent, Vost. (E)	Mioc. kkp	O	4670.3	39.4	0.130	0.30	1860	--	115	
Maylisu IV-Izbaskent, Vost. (E)	Olig. II (III)	O	14270.3	15.1	0.151	0.42	1923	--	74	7
Maylisu IV-Izbaskent, Vost. (E)	Eoc. V	O	13440.1	6.6	0.110	0.31	2012	--	118	
Maylisu IV-Izbaskent, Vost. (E)	Eoc. VIIa	O	11200.1	6.6	0.110	0.31	2056	--	119	
Maylisu IV-Izbaskent, Vost. (E)	Paleoc. IX	O	1124.3	6.6	0.160	0.35	2101	--	120	
Maylisu IV-Izbaskent, Vost. (E)	U. Cret. XIII	GO	1124.3	55.8	0.137	0.26	2176	--	109	611
Maylisu IV-Izbaskent, Vost. (E)	U. Cret. XIV	GO	1124.3	19.7	0.100	0.22	2393	--	111	547
Maylisu IV-Izbaskent, Vost. (E)	U. Cret. XV	G	1124.3	19.7	0.102	0.23	2611	525	118	431
Maylisu IV-Izbaskent, Vost. (E)	U. Cret. XVI	G	1124.3	19.7	0.130	0.29	2709	538	131	
Maylisu IV-Izbaskent, Vost. (E)	U. Cret. XVII	G	1124.3	19.7	0.125	0.25	2849	564	126	527
Maylisu IV-Izbaskent, Vost. (E)	L. Cret. XVIII	GC	1816.2	23.0	0.120	0.25	3227	607	134	527
Maylisu IV-Izbaskent, Vost. (E)	L. Cret. XIX	G	1816.2	12.1	0.100	0.33	4554	656	140	46
Maylisu IV-Izbaskent, Vost. (E)	L. Cret. XXII	G	1816.2	12.1	0.072	0.24	4728	722	149	20
Maylisu IV-Izbaskent, Vost. (E)	Jura. XXIII	G	1124.3	39.4	0.200	0.37	4308	748	152	172
Namangan	Eoc. V	O	4043.3	13.1	0.061	0.20	8820	--	194	76
Shorbulak	Eoc. V	O	1606.2	12.5	0.100	0.25	7397	--	204	
Tergachi	Mioc. kkp	O	2409.3	52.5	0.110	0.27	7397	--	186	
Tergachi	Eoc. V	O	2409.3	10.2	0.110	0.40	7658	--	302	2
South Flank - NE of Fergana										
Alamyshik, Sever. (N)	Olig. II (III)	O	2007.7	34.4	0.180	0.36	5526	--	158	
Alamyshik, Yuzh. (S)	Plioc. I+Ia	O	1141.6	55.8	0.180	0.34	522	--	91	204
Alamyshik, Yuzh. (S)	Plioc. Ib	O	1141.6	49.9	0.180	0.34	609	--	92	204
Alamyshik, Yuzh. (S)	Mioc. Ic	O	1141.6	26.2	0.210	0.40	658	--	95	90
Alamyshik, Yuzh. (S)	Olig. II (III)	O	1193.5	25.6	0.200	0.40	718	--	95	68
Alamyshik, Yuzh. (S)	Eoc. V-VII	O	795.7	41.3	0.100	0.25	667	--	96	68
Alamyshik, Yuzh. (S)	L. Cret. XVIII	O	518.9	55.8	0.170	0.34	1729	--	145	
Alamyshik, Yuzh. (S)	L. Cret. XIX-XXII	O	173.0	39.4	0.140	0.29	2138	--	122	
Alamyshik, Yuzh. (S)	Jura. XXIII	GO	173.0	32.8	0.100	0.36	2147	--	130	164
Andizhan	Plioc. I	GO	1037.8	27.6	0.090	0.22	363	--	88	241
Andizhan	Olig. III	GO	1003.2	23.0	0.180	0.40	754	--	98	34
Andizhan	Eoc. V	GO	207.6	24.6	0.200	0.34	841	--	101	365
Andizhan	Eoc. VI	GO	207.6	24.6	0.180	0.34	1029	--	109	
Andizhan	Eoc. VII	GO	207.6	45.9	0.180	0.33	1175	--	107	355
Andizhan	Paleoc. VIII	G	207.6	59.1	0.180	0.33	1015	312	87	35
Boston	Plioc. I	O	622.7	45.9	0.225	0.44	595	--	88	70

Table A3. Reservoir Parameter Estimates, by Reservoir for Fields Discovered through 1987, Fergana Basin (English Units) Continued

Field Name	Pay Zone Identification	Petro-leum Type	Reser-voir Area (acres)	Net Pay Thick-ness (ft)	Porosity (frac)	Water Satura-tion (frac)	Initial Reser-voir Pressure (psi)	Gas Reser-voir Abandon. Pressure (psi)	Initial Reser-voir Temper-ature (deg F)	Converted Perme-ability (md)
Boston	Mioc. Ia	O	968.7	34.1	0.150	0.34	363	--	75	41
Boston	Mioc. I	O	968.7	45.9	0.150	0.34	486	--	93	41
Boston	Olig. II (III)	O	968.7	26.9	0.160	0.34	754	--	72	81
Boston	Olig. III	O	622.7	27.9	0.160	0.33	798	--	97	91
Boston	L. Cret. XIX	G	207.6	52.5	0.150	0.34	3885	656	153	41
Boston	L. Cret. XX+XXI+XXII	GO	207.6	68.2	0.100	0.27	3104	--	146	22
Boston	Jura. XXVII	G	207.6	32.8	0.130	0.29	4743	787	156	91
Boston	Permo-Trias. XXX	O	207.6	13.1	0.100	0.35	4244	--	166	
Changyrtash	Olig. III	O	2223.9	26.2	0.200	0.39	899	--	149	
Changyrtash	Eoc. V	O	1482.6	16.4	0.150	0.31	899	--	95	
Chigirchik	Jura. XXIII	O	2409.3	39.4	0.110	0.25	1450	--	110	
Khartum	Olig. III	O	605.4	24.6	0.180	0.36	3713	--	148	
Khartum	Eoc. VI	O	605.4	24.6	0.145	0.39	3858	--	160	9
Khartum	Eoc. VII	G	302.7	21.7	0.145	0.29	3753	837	161	
Khartum	L. Cret. XXII	GO	605.4	39.4	0.140	0.29	4525	--	213	
Khartum, Vost. (E)	Olig. II-III	O	843.2	39.4	0.160	0.35	4554	--	140	46
Khartum. Vost. (E)	Eoc. VI	G	843.2	32.8	0.245	0.53	5055	728	154	23
Khodzhaosman	L. Cret. XVIII	O	380.5	13.1	0.200	0.39	885	--	96	
Palvantash	Plioc. I + Olig. III	O	207.6	45.9	0.100	0.37	595	--	88	2
Palvantash	Eoc. IV-VI	GO	864.9	42.7	0.240	0.48	841	--	96	41
Palvantash	Eoc. VII-VIII	GO	311.4	88.6	0.200	0.34	1175	--	104	507
Palvantash	U. Cret. XIII+XIV	G	864.9	32.8	0.125	0.27	1813	302	107	
Palvantash	L. Cret. XVIIIr	G	103.8	9.8	0.150	0.31	2829	591	136	
Palvantash, Zap. (W)	Mioc. brp	O	622.7	98.4	0.180	0.40	1907	--	123	34
Palvantash, Zap. (W)	Olig. IIIb	O	899.5	32.8	0.139	0.31	2712	--	145	71
Palvantash, Zap. (W)	Eoc. V+VI	O	685.0	21.7	0.095	0.25	3133	--	170	74
Palvantash, Zap. (W)	Eoc. VII	O	311.4	21.7	0.180	0.33	3060	--	178	410
Palvantash, Zap. (W)	Eoc. VIII-IX	O	622.7	9.8	0.180	0.33	3488	--	185	
Sharikhan-Khodzhiabad	Olig. II-III	O	2058.4	26.2	0.160	0.33	740	--	94	81
Sharikhan-Khodzhiabad	Eoc. V	O	1937.3	6.6	0.160	0.30	972	--	98	326
Sharikhan-Khodzhiabad	Eoc. VI	G	1937.3	9.8	0.160	0.30	972	226	100	326
Sharikhan-Khodzhiabad	Eoc. VII	O	2058.4	62.3	0.200	0.35	1030	--	95	351
Sharikhan-Khodzhiabad	Eoc. VIII	GO	2940.6	26.2	0.170	0.37	1639	--	162	40
Sharikhan-Khodzhiabad	L. Cret. XIX-XXII	GO	1937.3	105.0	0.148	0.33	2988	--	163	59
Sharikhan-Khodzhiabad	Jura. XXIII-XXIX	GO	1937.3	39.4	0.110	0.31	3799	--	157	10
Suzak	L. Cret. XIX	G	1927.4	52.5	0.147	0.32	2886	611	139	
Suzak	L. Cret. XXI	G	1927.4	52.5	0.155	0.33	4061	623	140	
South Flank - SW of Fergana										
Aksaray	Eoc. VII	G	618.4	28.5	0.170	0.40	1067	251	102	
Aksaray	Paleoc. VIII	G	618.4	19.7	0.140	0.33	1306	336	111	
Avval'	Eoc. V	O	1445.6	11.2	0.340	0.65	1131	--	100	11
Avval', Vost. (E)	Eoc. V	O	771.0	9.8	0.225	0.54	1421	--	113	12
Ayritan	Olig. II (III)	GO	1148.4	9.8	0.170	0.65	1857	--	118	0
Ayritan	Eoc. V	O	1148.4	9.8	0.180	0.47	1944	--	160	9
Ayritan	Eoc. VII	O	1148.4	28.5	0.200	0.45	2205	--	86	23
Ayritan	Paleoc. IX	G	1148.4	18.0	0.160	0.34	2277	517	129	74
Beshkent-Togap	Olig. II (III)	O	2891.1	14.8	0.180	0.44	2901	--	130	
Chaur-Yarkutan-Chimion	Eoc. IV	O	2594.0	13.8	0.190	0.40	411	--	87	
Chaur-Yarkutan-Chimion	Eoc. V, VI	O	2594.0	20.7	0.210	0.45	667	--	88	28
Chongara-Gal'cha	Eoc. IV	GO	8216.3	32.8	0.160	0.31	798	--	93	152
Chongara-Gal'cha	Eoc. V	G	5881.1	16.4	0.140	0.30	609	138	91	101
Chongara-Gal'cha	Eoc. VII	G	5881.1	36.1	0.210	0.41	609	151	92	61
Karagachi-Tamchi	Eoc. IV	O	10600.8	20.7	0.220	0.35	4590	--	158	791
Khankyz	Olig. II (III)	O	556.0	29.5	0.170	0.45	2205	--	109	7
Khankyz	Eoc. VII	O	1112.0	39.4	0.194	0.42	2495	--	133	12
Khankyz	L. Cret. XVIII	G	556.0	82.0	0.180	0.39	3989	812	176	35
Kim (Sel'rokho)	Olig. II (III)	O	6746.0	9.8	0.220	0.36	261	--	97	279

Table A3. Reservoir Parameter Estimates, by Reservoir for Fields Discovered through 1987, Fergana Basin (English Units) Continued

Field Name	Pay Zone Identification	Petroleum Type	Reservoir Area (acres)	Net Pay Thickness (ft)	Porosity (frac)	Water Saturation (frac)	Initial Reservoir Pressure (psi)	Gas Reservoir Abandon. Pressure (psi)	Initial Reservoir Temperature (deg F)	Converted Permeability (md)
Kim (Sel'rokho)	Eoc. V	O	6746.0	10.8	0.150	0.35	334	--	97	
Kim (Sel'rokho)	Eoc. VI	O	6746.0	18.4	0.200	0.41	893	--	98	
Kim (Sel'rokho)	Eoc. VIa	O	6746.0	9.8	0.210	0.42	907	--	98	
Kim (Sel'rokho)	Eoc. VII	O	6746.0	25.3	0.150	0.35	935	--	99	
Nefteabad	Olig. II (III)	GO	4336.7	13.8	0.150	0.43	827	--	112	6
Obi-Shifo	Olig. II-III	O	1204.6	19.7	0.180	0.44	891	--	100	
Rishtan, Sever. (N)	U. Cret. XIV	G	1606.2	16.4	0.128	0.28	885	189	97	189
Rishtan, Sever. (N)	U. Cret. XVI + XVII	O	1606.2	16.4	0.100	0.25	1247	--	102	74
Rishtan, Sever. (N)	L. Cret. XVIIIr	G	1606.2	13.1	0.100	0.23	1465	312	115	193
Rishtan, Sever. (N)	Jura. XXIII-XXIX	G	1606.2	39.4	0.250	0.50	1940	410	118	
Sarykamysh	U. Cret. XIV	G	835.2	19.7	0.160	0.33	551	103	95	80
Sarykamysh	L. Cret. XVIIr	G	835.2	26.2	0.101	0.23	940	213	94	
Sarykamysh	Jura. XXIII	G	835.2	39.4	0.250	0.50	1682	328	110	
Sarytok	Jura. XXVI	G	192.7	32.8	0.224	0.44	1726	377	115	66
Shorsu IV	Olig. II (III)	O	706.7	19.7	0.222	0.50	276	--	87	
Shorsu IV	Eoc. IV	O	706.7	9.8	0.222	0.45	334	--	88	
Shorsu IV	Eoc. V	OG	706.7	9.8	0.222	0.60	363	--	88	
Shorsu IV	Eoc. VI	O	706.7	9.8	0.222	0.45	508	--	90	
Shorsu IV	Eoc. VII	O	706.7	40.0	0.170	0.40	508	--	91	
Shorsu IV	Paleoc. VIII	O	706.7	12.1	0.140	0.33	508	--	92	
Shorsu IV	Paleoc. IX	O	706.7	9.8	0.150	0.33	508	--	93	
Shorsu VI	Eoc. VII	G	2088.0	40.0	0.170	0.40	446	105	87	
Sokh, Sever. (N)	Olig. II	OG	1798.9	45.9	0.240	0.50	1987	--	112	20
Sokh, Sever. (N)	Eoc. IV	GO	1798.9	9.8	0.170	0.39	1886	--	120	28
Sokh, Sever. (N)	Eoc. V	GC	1911.4	16.4	0.200	0.39	2161	443	123	96
Sokh, Sever. (N)	Eoc. VII	G	1124.3	50.2	0.125	0.28	2190	459	127	95
Sokh, Sever. (N)	Paleoc. VIII	O	1124.3	52.5	0.180	0.41	2263	--	133	24
Sokh, Sever. (N)	U. Cret. XIV-XV	GO	830.3	91.9	0.210	0.51	2437	--	137	10
Sokh, Sever. (N)	L. Cret. XVIIIr	GC	665.9	55.8	0.275	0.43	2640	591	111	287
Sokh, Sever. (N)	L. Cret. XXII	GC	665.9	19.7	0.100	0.33	3133	623	124	
Sokh, Sever. (N)	Jura. XXIV-XXV	GC	345.9	114.8	0.300	0.65	3517	689	145	15
Tasravet	Eoc. IV	O	1204.6	11.5	0.190	0.40	1097	--	103	
Central Basin Graben										
Achisu	Olig. II (III)	O	1284.9	19.7	0.170	0.36	5671	--	193	
Gumkhana	Plioc. I	O	2409.3	39.4	0.100	0.25	12291	--	219	
Gumkhana	Mioc.(?)	O	2409.3	100.1	0.100	0.25	13434	--	233	
Kanibadam	Eoc. V	O	916.8	9.8	0.160	0.36	4102	--	176	30
Kanibadam	Eoc. VII	O	916.8	29.9	0.150	0.35	4409	--	176	
Kanibadam	Paleoc. IX+IXa	GC	733.4	57.4	0.160	0.31	4931	1031	199	196
Kanibadam, Sever. (N)	Olig. II (III)	O	1966.0	9.8	0.170	0.36	4192	--	174	
Madaniyat	Olig. II	O	2409.3	9.8	0.170	0.36	7320	--	203	
Madaniyat	Eoc. IV	O	2409.3	9.8	0.180	0.38	6215	--	204	
Madaniyat	Eoc. VII	O	2409.3	29.9	0.170	0.36	7397	--	205	
Makhram	Olig. II-III	O	1204.6	11.8	0.170	0.36	6202	--	193	
Mingbulak	Mioc. kkp	O	8006.2	125.0	0.220	0.35	18375	--	287	
Mingbulak	Olig. III	O	8006.2	42.7	0.200	0.35	17200	--	305	
Mingbulak	Paleoc. VIII	O	8006.2	39.4	0.150	0.35	15875	--	320	
Mingbulak	Paleoc. IX	GC	8006.2	39.4	0.150	0.35	15597	1935	322	
Niyazbek-Karakchikum	Olig. II (III)	O	6642.2	10.5	0.185	0.39	7731	--	201	
Niyazbek-Karakchikum	Eoc. IV	O	5189.2	9.8	0.180	0.38	6134	--	202	
Niyazbek-Karakchikum	Eoc. V	O	3459.5	10.5	0.170	0.40	6802	--	203	
Niyazbek-Karakchikum	Eoc. VI	GC	3459.5	10.5	0.180	0.43	7320	1250	203	
Niyazbek-Karakchikum	Eoc. VIIa	GC	3459.5	30.8	0.170	0.36	6326	1257	204	
Niyazbek-Karakchikum	Paleoc. IX	GC	2421.6	24.6	0.160	0.35	6352	1263	204	
Niyazbek-Karakchikum	U. Cret. XI-XII	GC	2421.6	19.7	0.150	0.33	6435	1280	206	
Ravat	Olig. II (III)	O	1003.2	39.4	0.180	0.40	4540	--	140	28
Ravat	Eoc. IV	O	802.6	45.9	0.150	0.40	4772	--	185	9

Table A3. Reservoir Parameter Estimates, by Reservoir for Fields Discovered through 1987, Fergana Basin (English Units) Continued

Field Name	Pay Zone Identification	Petro-leum Type	Reser-voir Area (acres)	Net Pay Thick-ness (ft)	Porosity (frac)	Water Satura-tion (frac)	Initial Reser-voir Pressure (psi)	Gas Reser-voir Abandon. Pressure (psi)	Initial Reser-voir Temper-ature (deg F)	Converted Perme-ability (md)
Ravat	Eoc. V	GC	1003.2	9.8	0.170	0.40	4888	1079	186	43
Ravat	Eoc. VII	O	1003.2	19.7	0.150	0.38	5207	--	158	14
Ravat	Paleoc. IX-IXa	GC	802.6	32.8	0.100	0.25	6730	1165	162	
Varyk	Olig. II (III)	O	2409.3	17.7	0.170	0.36	5381	--	183	
Varyk	Eoc. IV	O	2409.3	9.8	0.180	0.38	5381	--	193	
Varyk	Eoc. V	G	2409.3	11.2	0.118	0.28	5715	1165	194	
Varyk	Eoc. VII	O	2409.3	29.9	0.150	0.35	5381	--	200	
Varyk	Paleoc. IX	O	2409.3	24.6	0.180	0.38	5642	--	203	
Varyk II	Olig. II (III)	O	1284.9	16.7	0.120	0.26	10312	--	205	241
Varyk II	Eoc. IV	O	1284.9	9.8	0.180	0.38	10443	--	244	
Varyk II	Eoc. VII	O	1284.9	32.2	0.120	0.29	8423	--	246	
Total 53 fields and field-combinations	177 reservoirs	121 O-GO-OG 56 G-GC reservoirs								

Notes: At least 7 additional fields exist (1993 Uzbek & Petroconsultants information), which were probably discovered after 1987.

Volumetric calculations used piecemeal data sources and estimates. Some of the most sensitive data to calculations (reservoir area and thickness), were the least reliable.

Listing of fields in the central basin graben is from Glumakov, et al, 1988; not all are deep-basin.

Initial field discovery year used for all reservoirs in that field.

For Mingbulak field, data listed with 1987* (asterisk) discovery year relate to estimates following the 1992 oil blowout.

Totals may not equal sum of components due to independent rounding. Other calculations also use complete values rather than the rounded values shown.

N-E-S-W as directions of north, east, south, and west.

? = particularly questionable.

Pay Zones as Plioc., Mioc., Olig., Eoc., Paleoc. are epochs of Tertiary Period (Pliocene, Miocene, Oligocene, Eocene, Paleocene). U. and L. Cret. are Upper and Lower Cretaceous Epochs. Jura. is Jurassic Period and Permo-Trias. is a composite zone of the Permian-Triassic Periods.

Pet. Type as petroleum in the reservoir; O = oil, G = natural gas, GC = gas condensate; when GO or OG is listed, the last letter indicates dominance in the pay.

Units as ft = feet; frac = decimal fraction; psi = pounds per square inch (assumed absolute); deg F = degrees Fahrenheit; md = millidarcies permeability, converted from reported (see Table E3).

Source: Energy Information Administration, Office of Oil and Gas.

Table A4. Selected Oil Parameter Estimates, by Reservoir for Fields Discovered through 1987, Fergana Basin (English Units)

Field Name	Pay Zone Identification	Petro-leum Type	Oil Density (degrees API)	Initial Oil Formation Volume Factor (bbl/stb)	Oil Reservoir Richness (recoverable stb/ac-ft)	Total Primary Oil Recovery Efficiency (frac)	Primary Ultimate Recoverable Oil (MMstb)	Improved Recovery Oil, via Waterflood (MMstb)
North Basin Flank								
Bedresay	L. Cret. XVIIIg	G	--	--	--	--	--	--
Izbaskent	Olig. II (III)	O	32.0	1.167	134.230	0.17	1.303	0.000
Izbaskent	Eoc. V-VII	O	34.0	1.198	63.411	0.08	0.957	0.000
Izbaskent	Paleoc. IX	O	33.5	1.200	116.969	0.18	1.766	0.000
Izbaskent	Paleoc. X	O	33.5	1.204	123.006	0.19	1.857	0.000
Izbaskent	U. Cret. XII	G	--	--	--	--	--	--
Izbaskent	U. Cret. XIII	G	--	--	--	--	--	--
Izbaskent	U. Cret. XIV	G	--	--	--	--	--	--
Izbaskent	U. Cret. XV	G	--	--	--	--	--	--
Izbaskent	L. Cret. XVIII	G	--	--	--	--	--	--
Kassansay	Olig. II (III)	O	33.0	1.287	344.828	0.55	8.177	0.000
Kyzyl-Alma	Jura. XXIII	G	--	--	--	--	--	--
Maylisay	Eoc. V	O	31.5	1.094	166.117	0.32	1.943	0.000
Maylisu III	Olig. II (III)	O	33.0	1.303	154.774	0.17	2.246	1.057
Maylisu III	Eoc. V	O	34.0	1.319	110.288	0.17	1.316	0.619
Maylisu III	Eoc. VII	O	34.0	1.353	48.850	0.07	0.843	0.361
Maylisu III	U. Cret. XIII	G	--	--	--	--	--	--
Maylisu III	U. Cret. XVII	G	--	--	--	--	--	--
Maylisu III	L. Cret. XVIIIa	G	--	--	--	--	--	--
Maylisu III	Jura. XXIII	G	--	--	--	--	--	--
Maylisu IV-Izbaskent, Vost. (E)	Mioc. kkr	O	31.0	1.106	140.464	0.15	17.609	8.218
Maylisu IV-Izbaskent, Vost. (E)	Olig. II (III)	O	31.0	1.099	55.634	0.09	11.982	0.000
Maylisu IV-Izbaskent, Vost. (E)	Eoc. V	O	32.5	1.130	52.094	0.10	4.594	0.000
Maylisu IV-Izbaskent, Vost. (E)	Eoc. VIIa	O	32.5	1.145	51.435	0.10	3.780	0.000
Maylisu IV-Izbaskent, Vost. (E)	Paleoc. IX	O	32.0	1.156	118.703	0.17	0.876	0.000
Maylisu IV-Izbaskent, Vost. (E)	U. Cret. XIII	GO	43.0	1.276	295.809	0.32	12.367	6.183
Maylisu IV-Izbaskent, Vost. (E)	U. Cret. XIV	GO	43.0	1.275	147.138	0.21	2.206	1.050
Maylisu IV-Izbaskent, Vost. (E)	U. Cret. XV	G	--	--	--	--	--	--
Maylisu IV-Izbaskent, Vost. (E)	U. Cret. XVI	G	--	--	--	--	--	--
Maylisu IV-Izbaskent, Vost. (E)	U. Cret. XVII	G	--	--	--	--	--	--
Maylisu IV-Izbaskent, Vost. (E)	L. Cret. XVIII	GC	--	--	--	--	--	--
Maylisu IV-Izbaskent, Vost. (E)	L. Cret. XIX	G	--	--	--	--	--	--
Maylisu IV-Izbaskent, Vost. (E)	L. Cret. XXII	G	--	--	--	--	--	--
Maylisu IV-Izbaskent, Vost. (E)	Jura. XXIII	G	--	--	--	--	--	--
Namangan	Eoc. V	O	35.0	1.406	34.995	0.13	1.857	0.000
Shorbulak	Eoc. V	O	36.0	1.416	176.656	0.43	3.537	0.000
Tergachi	Mioc. kkr	O	36.0	1.281	282.088	0.58	35.676	0.000
Tergachi	Eoc. V	O	36.0	1.378	152.369	0.41	3.734	0.000
South Flank - NE of Fergana								
Alamyshik, Sever. (N)	Olig. II (III)	O	39.0	1.244	150.835	0.21	10.432	0.000
Alamyshik, Yuzh. (S)	Plioc. I+Ia	O	39.0	1.144	96.681	0.08	4.104	2.052
Alamyshik, Yuzh. (S)	Plioc. Ib	O	39.0	1.121	246.662	0.20	9.362	4.681
Alamyshik, Yuzh. (S)	Mioc. Ic	O	39.0	1.116	262.887	0.20	5.251	2.626
Alamyshik, Yuzh. (S)	Olig. II (III)	O	39.0	1.079	258.948	0.20	5.273	2.636
Alamyshik, Yuzh. (S)	Eoc. V-VII	O	39.0	1.075	70.372	0.09	1.602	0.712
Alamyshik, Yuzh. (S)	L. Cret. XVIII	O	42.0	1.128	169.739	0.22	4.913	0.000
Alamyshik, Yuzh. (S)	L. Cret. XIX-XXII	O	43.0	1.136	156.129	0.23	1.063	0.000
Alamyshik, Yuzh. (S)	Jura. XXIII	GO	44.0	1.182	96.582	0.23	0.548	0.000
Andizhan	Plioc. I	GO	32.0	1.123	77.598	0.16	2.219	0.000
Andizhan	Olig. III	GO	34.0	1.254	167.046	0.25	3.849	0.000
Andizhan	Eoc. V	GO	35.0	1.343	61.004	0.08	0.312	0.000
Andizhan	Eoc. VI	GO	35.0	1.358	54.297	0.08	0.277	0.000
Andizhan	Eoc. VII	GO	36.0	1.412	53.012	0.08	0.505	0.000
Andizhan	Paleoc. VIII	G	--	--	--	--	--	--
Boston	Plioc. I	O	34.6	1.040	234.989	0.17	4.570	2.151
Boston	Mioc. Ia	O	34.6	1.094	175.561	0.17	3.946	1.857

Table A4. Selected Oil Parameter Estimates, by Reservoir for Fields Discovered through 1987, Fergana Basin (English Units) Continued

Field Name	Pay Zone Identification	Petro-leum Type	Oil Density (degrees API)	Initial Oil Formation Volume Factor (bbl/stb)	Oil Reservoir Richness (recoverable stb/ac-ft)	Total Primary Oil Recovery Efficiency (frac)	Primary Ultimate Recoverable Oil (MMstb)	Improved Recovery Oil, via Waterflood (MMstb)
Boston	Mioc. I	O	34.6	1.165	178.010	0.18	5.280	2.640
Boston	Olig. II (III)	O	34.4	1.095	202.015	0.18	3.510	1.755
Boston	Olig. III	O	34.4	1.151	195.098	0.18	2.259	1.129
Boston	L. Cret. XIX	G	--	--	--	--	--	--
Boston	L. Cret. XX+XXI+XXII	GO	43.0	1.305	91.143	0.21	1.291	0.000
Boston	Jura. XXVII	G	--	--	--	--	--	--
Boston	Permo-Trias. XXX	O	33.0	1.394	50.643	0.14	0.138	0.000
Changyrtash	Olig. III	O	32.0	1.192	198.515	0.17	7.880	3.708
Changyrtash	Eoc. V	O	34.0	1.146	70.069	0.07	1.193	0.511
Chigirchik	Jura. XXIII	O	33.0	1.058	290.486	0.48	27.554	0.000
Khartum	Olig. III	O	40.0	1.256	149.442	0.21	2.226	0.000
Khartum	Eoc. VI	O	40.0	1.366	115.541	0.23	1.721	0.000
Khartum	Eoc. VII	G	--	--	--	--	--	--
Khartum	L. Cret. XXII	GO	44.0	1.519	71.066	0.14	1.694	0.000
Khartum, Vost. (E)	Olig. II-III	O	40.0	1.270	247.824	0.39	8.227	0.000
Khartum. Vost. (E)	Eoc. VI	G	--	--	--	--	--	--
Khodzhaosman	L. Cret. XVIII	O	40.0	1.149	164.756	0.20	0.823	0.000
Palvantash	Plioc. I + Olig. III	O	31.0	1.021	162.766	0.34	1.552	0.000
Palvantash	Eoc. IV-VI	GO	34.0	1.030	282.013	0.30	10.403	0.000
Palvantash	Eoc. VII-VIII	GO	34.0	1.052	292.008	0.30	8.054	0.000
Palvantash	U. Cret. XIII+XIV	G	--	--	--	--	--	--
Palvantash	L. Cret. XVIIIg	G	--	--	--	--	--	--
Palvantash, Zap. (W)	Mioc. bgr	O	39.0	1.084	394.339	0.51	24.169	0.000
Palvantash, Zap. (W)	Olig. IIIb	O	30.0	1.064	328.627	0.47	9.698	0.000
Palvantash, Zap. (W)	Eoc. V+VI	O	30.0	1.200	239.605	0.52	3.554	0.000
Palvantash, Zap. (W)	Eoc. VII	O	30.0	1.145	286.067	0.35	1.929	0.000
Palvantash, Zap. (W)	Eoc. VIII-IX	O	30.0	1.202	327.064	0.42	2.005	0.000
Sharikhan-Khodzhiabad	Olig. II-III	O	34.0	1.128	184.330	0.17	6.772	3.187
Sharikhan-Khodzhiabad	Eoc. V	O	38.0	1.130	69.185	0.09	0.879	0.000
Sharikhan-Khodzhiabad	Eoc. VI	G	--	--	--	--	--	--
Sharikhan-Khodzhiabad	Eoc. VII	O	38.0	1.125	80.668	0.09	10.351	0.000
Sharikhan-Khodzhiabad	Eoc. VIII	GO	34.0	1.277	273.287	0.42	21.092	0.000
Sharikhan-Khodzhiabad	L. Cret. XIX-XXII	GO	42.0	1.324	325.511	0.56	66.206	0.000
Sharikhan-Khodzhiabad	Jura. XXIII-XXIX	GO	43.0	1.326	208.676	0.47	15.916	0.000
Suzak	L. Cret. XIX	G	--	--	--	--	--	--
Suzak	L. Cret. XXI	G	--	--	--	--	--	--
South Flank - SW of Fergana								
Aksaray	Eoc. VII	G	--	--	--	--	--	--
Aksaray	Paleoc. VIII	G	--	--	--	--	--	--
Avval'	Eoc. V	O	36.0	1.121	403.423	0.49	6.505	0.000
Avval', Vost. (E)	Eoc. V	O	35.0	1.110	289.468	0.40	2.197	0.000
Ayritan	Olig. II (III)	GO	35.5	1.120	24.737	0.06	0.280	0.000
Ayritan	Eoc. V	O	35.5	1.144	38.831	0.06	0.439	0.000
Ayritan	Eoc. VII	O	36.5	1.129	90.708	0.08	1.982	0.991
Ayritan	Paleoc. IX	G	--	--	--	--	--	--
Beshkent-Togap	Olig. II (III)	O	31.0	1.069	182.931	0.17	5.310	2.499
Chaur-Yarkutan-Chimion	Eoc. IV	O	31.7	1.049	185.491	0.15	4.521	2.110
Chaur-Yarkutan-Chimion	Eoc. V, VI	O	31.0	1.053	204.237	0.16	7.300	3.650
Chongara-Gal'cha	Eoc. IV	GO	31.0	1.501	125.540	0.22	33.841	0.000
Chongara-Gal'cha	Eoc. V	G	--	--	--	--	--	--
Chongara-Gal'cha	Eoc. VII	G	--	--	--	--	--	--
Karagachi-Tamchi	Eoc. IV	O	33.0	1.317	244.343	0.29	53.538	0.000
Khankyz	Olig. II (III)	O	29.0	1.057	219.589	0.32	3.605	0.000
Khankyz	Eoc. VII	O	26.0	1.056	314.110	0.38	13.751	0.000
Khankyz	L. Cret. XVIII	G	--	--	--	--	--	--
Kim (Sel'rokho)	Olig. II (III)	O	34.0	1.107	246.698	0.17	11.138	5.242
Kim (Sel'rokho)	Eoc. V	O	36.0	1.129	80.401	0.08	3.915	1.957
Kim (Sel'rokho)	Eoc. VI	O	36.0	1.133	218.166	0.18	18.027	9.013

Table A4. Selected Oil Parameter Estimates, by Reservoir for Fields Discovered through 1987, Fergana Basin (English Units) Continued

Field Name	Pay Zone Identification	Petroleum Type	Oil Density (degrees API)	Initial Oil Formation Volume Factor (bbl/stb)	Oil Reservoir Richness (recoverable stb/ac-ft)	Total Primary Oil Recovery Efficiency (frac)	Primary Ultimate Recoverable Oil (MMstb)	Improved Recovery Oil, via Waterflood (MMstb)
Kim (Sel'rokho)	Eoc. VIa	O	36.0	1.134	224.993	0.18	9.959	4.980
Kim (Sel'rokho)	Eoc. VII	O	36.0	1.129	80.371	0.08	9.131	4.566
Nefteabad	Olig. II (III)	GO	35.0	1.121	59.174	0.10	3.536	0.000
Obi-Shifo	Olig. II-III	O	34.0	1.108	176.463	0.17	2.845	1.339
Rishtan, Sever. (N)	U. Cret. XIV	G	--	--	--	--	--	--
Rishtan, Sever. (N)	U. Cret. XVI + XVII	O	35.0	1.158	135.671	0.18	2.383	1.192
Rishtan, Sever. (N)	L. Cret. XVIIIg	G	--	--	--	--	--	--
Rishtan, Sever. (N)	Jura. XXIII-XXIX	G	--	--	--	--	--	--
Sarykamysh	U. Cret. XIV	G	--	--	--	--	--	--
Sarykamysh	L. Cret. XVII	G	--	--	--	--	--	--
Sarykamysh	Jura. XXIII	G	--	--	--	--	--	--
Sarytok	Jura. XXVI	G	--	--	--	--	--	--
Shorsu IV	Olig. II (III)	O	33.0	1.080	199.347	0.17	1.886	0.887
Shorsu IV	Eoc. IV	O	34.0	1.102	214.904	0.17	1.017	0.478
Shorsu IV	Eoc. V	OG	35.0	1.113	49.520	0.08	0.344	0.000
Shorsu IV	Eoc. VI	O	35.0	1.108	230.839	0.18	1.070	0.535
Shorsu IV	Eoc. VII	O	33.0	1.104	71.681	0.07	1.419	0.608
Shorsu IV	Paleoc. VIII	O	32.0	1.116	65.209	0.07	0.392	0.168
Shorsu IV	Paleoc. IX	O	31.0	1.128	165.897	0.16	0.769	0.385
Shorsu VI	Eoc. VII	G	--	--	--	--	--	--
Sokh, Sever. (N)	Olig. II	OG	35.0	1.120	157.962	0.19	13.052	0.000
Sokh, Sever. (N)	Eoc. IV	GO	35.0	1.116	93.707	0.09	1.149	0.511
Sokh, Sever. (N)	Eoc. V	GC	--	--	--	--	--	--
Sokh, Sever. (N)	Eoc. VII	G	--	--	--	--	--	--
Sokh, Sever. (N)	Paleoc. VIII	O	36.0	1.134	94.471	0.09	3.860	1.716
Sokh, Sever. (N)	U. Cret. XIV-XV	GO	37.0	1.265	69.412	0.11	5.294	0.000
Sokh, Sever. (N)	L. Cret. XVIIIg	GC	--	--	--	--	--	--
Sokh, Sever. (N)	L. Cret. XXII	GC	--	--	--	--	--	--
Sokh, Sever. (N)	Jura. XXIV-XXV	GC	--	--	--	--	--	--
Tasravet	Eoc. IV	O	37.0	1.153	207.109	0.19	2.016	0.849
Central Basin Graben:								
Achisu	Olig. II (III)	O	36.0	1.237	136.462	0.20	3.452	0.000
Gumkhana	Plioc. I	O	34.0	1.468	63.420	0.16	6.016	0.000
Gumkhana	Mioc.(?)	O	34.0	1.512	57.726	0.15	13.917	0.000
Kanibadam	Eoc. V	O	32.0	1.237	51.382	0.08	0.464	0.000
Kanibadam	Eoc. VII	O	32.0	1.232	55.274	0.09	1.513	0.000
Kanibadam	Paleoc. IX+IXa	GC	--	--	--	--	--	--
Kanibadam, Sever. (N)	Olig. II (III)	O	39.0	1.273	139.295	0.21	2.695	0.000
Madaniyat	Olig. II	O	33.0	1.236	136.533	0.20	3.238	0.000
Madaniyat	Eoc. IV	O	33.0	1.248	131.792	0.19	3.125	0.000
Madaniyat	Eoc. VII	O	33.0	1.235	133.972	0.20	9.637	0.000
Makhram	Olig. II-III	O	36.0	1.257	134.291	0.20	1.911	0.000
Mingbulak	Mioc. kkp	O	30.2	1.600	110.945	0.16	111.031	0.000
Mingbulak	Olig. III	O	35.0	1.724	93.604	0.16	31.963	0.000
Mingbulak	Paleoc. VIII	O	42.1	1.744	69.398	0.16	21.875	0.000
Mingbulak	Paleoc. IX	GC	--	--	--	--	--	--
Niyazbek-Karakchikum	Olig. II (III)	O	33.0	1.278	137.003	0.20	9.554	0.000
Niyazbek-Karakchikum	Eoc. IV	O	33.0	1.303	132.881	0.20	6.787	0.000
Niyazbek-Karakchikum	Eoc. V	O	33.0	1.301	60.833	0.10	2.209	0.000
Niyazbek-Karakchikum	Eoc. VI	GC	--	--	--	--	--	--
Niyazbek-Karakchikum	Eoc. VIIa	GC	--	--	--	--	--	--
Niyazbek-Karakchikum	Paleoc. IX	GC	--	--	--	--	--	--
Niyazbek-Karakchikum	U. Cret. XI-XII	GC	--	--	--	--	--	--
Ravat	Olig. II (III)	O	40.0	1.812	272.827	0.59	10.776	0.000
Ravat	Eoc. IV	O	29.0	1.124	204.933	0.33	7.555	0.000
Ravat	Eoc. V	GC	--	--	--	--	--	--
Ravat	Eoc. VII	O	31.0	1.372	226.178	0.43	4.467	0.000
Ravat	Paleoc. IX-IXa	GC	--	--	--	--	--	--

Table A4. Selected Oil Parameter Estimates, by Reservoir for Fields Discovered through 1987, Fergana Basin (English Units) Continued

Field Name	Pay Zone Identification	Petro-leum Type	Oil Density (degrees API)	Initial Oil Formation Volume Factor (bbl/stb)	Oil Reservoir Richness (recoverable stb/ac-ft)	Total Primary Oil Recovery Efficiency (frac)	Primary Ultimate Recoverable Oil (MMstb)	Improved Recovery Oil, via Waterflood (MMstb)
Varyk	Olig. II (III)	O	40.0	1.276	138.940	0.21	5.931	0.000
Varyk	Eoc. IV	O	31.0	1.363	120.665	0.19	2.861	0.000
Varyk	Eoc. V	G	--	--	--	--	--	--
Varyk	Eoc. VII	O	32.5	1.352	50.349	0.09	3.622	0.000
Varyk	Paleoc. IX	O	33.0	1.355	121.431	0.19	7.199	0.000
Varyk II	Olig. II (III)	O	41.0	1.345	117.796	0.23	2.533	0.000
Varyk II	Eoc. IV	O	36.0	1.369	88.563	0.14	1.120	0.000
Varyk II	Eoc. VII	O	36.0	1.375	43.272	0.09	1.788	0.000
Total 53 fields and field-combinations	177 reservoirs	121 O-GO-OG 56 G-GC reservoirs					926.935 MMstb Pri. Oil	90.809 MMstb WF. Oil

Notes: At least 7 additional fields exist (1993 Uzbek & Petroconsultants information), which were probably discovered after 1987.

Volumetric calculations used piecemeal data sources and estimates. Some of the most sensitive data to calculations (reservoir area and thickness), were the least reliable.

Listing of fields in the central basin graben is from Glumakov, et al, 1988; not all are deep-basin.

Initial field discovery year used for all reservoirs in that field.

For Mingbulak field, data listed with 1983* (asterisk) discovery dates relate to estimates following the 1992 oil blowout.

Totals may not equal sum of components due to independent rounding. Other calculations also use complete values rather than the rounded values shown.

N-E-S-W as directions of north, east, south, and west.

Pay Zones as Plioc., Mioc., Olig., Eoc., Paleoc. are epochs of Tertiary Period (Pliocene, Miocene, Oligocene, Eocene, Paleocene). U. an L. Cret. are Upper and Lower Cretaceous Epochs. Jura. is Jurassic Period and Permo-Trias. is a composite zone of the Permian-Triassic Periods.

Petroleum Type as that in the reservoir; O = oil, G = natural gas, GC = gas condensate; when GO or OG is listed, the last letter indicates dominance.

API indicates American Petroleum Institute unit of density, at basically, stock tank conditions.

Richness as recoverable barrels of stock tank oil per acre-foot (ac-ft) of reservoir bulk volume.

Units as MMbbl = million barrels oil in the reservoir; MMstb = million stock tank barrels oil.

Primary (pri.) = oil recovery mechanism, including liquid expansion; frac = decimal fraction; Waterflood (wf.) = improved oil recovery by waterflood.

Source: Energy Information Administration, Office of Oil and Gas.

Table A5. Selected Gas Parameter Estimates, by Reservoir for Fields Discovered through 1987, Fergana Basin (English Units)

Field Name	Pay Zone Identification	Petro-leum Type	Gas Gravity (air=1.0)	Initial Gas Formation Volume Factor (cf/scf)	NA Gas Recovery Efficiency (frac)	Initial Gas-Oil Ratio, GOR (scf/stb)	Ultimate Recoverable Primary A-D Gas (MMscf)	Ultimate Recoverable Waterflood A-D Gas (MMscf)
North Basin Flank								
Bedresay	L. Cret. XVIIIg	G	0.6670	0.003635	0.73	--	--	--
Izbaskent	Olig. II (III)	O	0.9420	--	--	340.120	443.041	0.000
Izbaskent	Eoc. V-VII	O	0.9420	--	--	393.638	376.799	0.000
Izbaskent	Paleoc. IX	O	0.8500	--	--	375.575	663.156	0.000
Izbaskent	Paleoc. X	O	0.8500	--	--	385.205	715.260	0.000
Izbaskent	U. Cret. XII	G	0.6670	0.003714	0.77	--	--	--
Izbaskent	U. Cret. XIII	G	0.6210	0.003994	0.75	--	--	--
Izbaskent	U. Cret. XIV	G	0.6670	0.003775	0.73	--	--	--
Izbaskent	U. Cret. XV	G	0.6670	0.003729	0.72	--	--	--
Izbaskent	L. Cret. XVIII	G	0.6670	0.003732	0.71	--	--	--
Kassansay	Olig. II (III)	O	0.8260	--	--	555.411	4541.610	0.000
Kyzyl-Alma	Jura. XXIII	G	0.6670	0.003859	0.74	--	--	--
Maylisay	Eoc. V	O	0.8500	--	--	185.213	359.930	0.000
Maylisu III	Olig. II (III)	O	0.8260	--	--	531.263	1193.310	561.558
Maylisu III	Eoc. V	O	0.8500	--	--	624.061	821.273	386.481
Maylisu III	Eoc. VII	O	0.8500	--	--	624.061	526.276	225.547
Maylisu III	U. Cret. XIII	G	0.6670	0.008735	0.84	--	--	--
Maylisu III	U. Cret. XVII	G	0.6670	0.005497	0.84	--	--	--
Maylisu III	L. Cret. XVIIIa	G	0.6670	0.005097	0.84	--	--	--
Maylisu III	Jura. XXIII	G	0.6670	0.004031	0.81	--	--	--
Maylisu IV-Izbaskent, Vost. (E)	Mioc. kkr	O	1.0310	--	--	195.567	3443.818	1607.115
Maylisu IV-Izbaskent, Vost. (E)	Olig. II (III)	O	0.9140	--	--	202.901	2431.112	0.000
Maylisu IV-Izbaskent, Vost. (E)	Eoc. V	O	0.9140	--	--	242.213	1112.754	0.000
Maylisu IV-Izbaskent, Vost. (E)	Eoc. VIIa	O	0.8500	--	--	268.857	1016.280	0.000
Maylisu IV-Izbaskent, Vost. (E)	Paleoc. IX	O	0.8500	--	--	291.532	255.303	0.000
Maylisu IV-Izbaskent, Vost. (E)	U. Cret. XIII	GO	0.6560	--	--	523.580	6474.858	3237.429
Maylisu IV-Izbaskent, Vost. (E)	U. Cret. XIV	GO	0.6560	--	--	523.580	1155.036	550.017
Maylisu IV-Izbaskent, Vost. (E)	U. Cret. XV	G	0.6670	0.004951	0.81	--	--	--
Maylisu IV-Izbaskent, Vost. (E)	U. Cret. XVI	G	0.6670	0.004993	0.80	--	--	--
Maylisu IV-Izbaskent, Vost. (E)	U. Cret. XVII	G	0.6470	0.004758	0.80	--	--	--
Maylisu IV-Izbaskent, Vost. (E)	L. Cret. XVIII	GC	0.6470	0.004387	0.80	--	--	--
Maylisu IV-Izbaskent, Vost. (E)	L. Cret. XIX	G	0.6670	0.003469	0.82	--	--	--
Maylisu IV-Izbaskent, Vost. (E)	L. Cret. XXII	G	0.6670	0.003461	0.80	--	--	--
Maylisu IV-Izbaskent, Vost. (E)	Jura. XXIII	G	0.6670	0.003698	0.79	--	--	--
Namangan	Eoc. V	O	0.9550	--	--	839.744	1559.314	0.000
Shorbulak	Eoc. V	O	0.8500	--	--	830.060	2936.317	0.000
Tergachi	Mioc. kkr	O	1.0310	--	--	569.184	20306.243	0.000
Tergachi	Eoc. V	O	0.8500	--	--	664.048	2479.299	0.000
South Flank - NE of Fergana								
Alamyshik, Sever. (N)	Olig. II (III)	O	0.8260	--	--	465.954	4861.006	0.000
Alamyshik, Yuzh. (S)	Plioc. I+Ia	O	1.1200	--	--	279.573	1147.370	573.685
Alamyshik, Yuzh. (S)	Plioc. Ib	O	1.1200	--	--	232.977	2181.108	1090.554
Alamyshik, Yuzh. (S)	Mioc. Ic	O	1.1200	--	--	218.999	1150.053	575.027
Alamyshik, Yuzh. (S)	Olig. II (III)	O	1.1200	--	--	139.786	737.047	368.523
Alamyshik, Yuzh. (S)	Eoc. V-VII	O	1.1200	--	--	130.467	209.072	92.921
Alamyshik, Yuzh. (S)	L. Cret. XVIII	O	0.7525	--	--	183.148	899.741	0.000
Alamyshik, Yuzh. (S)	L. Cret. XIX-XXII	O	0.7525	--	--	227.643	242.039	0.000
Alamyshik, Yuzh. (S)	Jura. XXIII	GO	0.7525	--	--	316.893	173.690	0.000
Andizhan	Plioc. I	GO	1.0310	--	--	242.943	539.198	0.000
Andizhan	Olig. III	GO	0.8240	--	--	504.049	1939.996	0.000
Andizhan	Eoc. V	GO	0.8550	--	--	691.835	215.560	0.000
Andizhan	Eoc. VI	GO	0.8550	--	--	715.691	198.477	0.000
Andizhan	Eoc. VII	GO	0.8550	--	--	831.957	420.483	0.000
Andizhan	Paleoc. VIII	G	0.8550	0.010744	0.74	--	--	--
Boston	Plioc. I	O	0.6870	--	--	52.614	240.465	113.160
Boston	Mioc. Ia	O	1.1500	--	--	191.323	754.900	355.247

Table A5. Selected Gas Parameter Estimates, by Reservoir for Fields Discovered through 1987, Fergana Basin (English Units) Continued

Field Name	Pay Zone Identification	Petro-leum Type	Gas Gravity (air=1.0)	Initial Gas Formation Volume Factor (cf/scf)	NA Gas Recovery Efficiency (frac)	Initial Gas-Oil Ratio, GOR (scf/stb)	Ultimate Recoverable Primary A-D Gas (MMscf)	Ultimate Recoverable Waterflood A-D Gas (MMscf)
Boston	Mioc. I	O	1.1500	--	--	330.031	1742.564	871.282
Boston	Olig. II (III)	O	0.8580	--	--	191.547	672.257	336.129
Boston	Olig. III	O	0.8580	--	--	287.321	648.957	324.478
Boston	L. Cret. XIX	G	0.6500	0.004004	0.78	--	--	--
Boston	L. Cret. XX+XXI+XXII	GO	0.6790	--	--	550.897	711.219	0.000
Boston	Jura. XXVII	G	0.6670	0.003515	0.79	--	--	--
Boston	Permo-Trias. XXX	O	0.6790	--	--	724.534	99.951	0.000
Changyrtash	Olig. III	O	0.8450	--	--	327.973	2584.287	1216.135
Changyrtash	Eoc. V	O	0.7920	--	--	276.987	330.424	141.610
Chigirchik	Jura. XXIII	O	0.6790	--	--	72.445	1996.118	0.000
Khartum	Olig. III	O	0.8260	--	--	486.422	1082.881	0.000
Khartum	Eoc. VI	O	0.7580	--	--	693.962	1194.445	0.000
Khartum	Eoc. VII	G	0.7560	0.003993	0.74	--	--	--
Khartum	L. Cret. XXII	GO	0.6790	--	--	905.408	1533.624	0.000
Khartum, Vost. (E)	Olig. II-III	O	0.6850	--	--	509.585	4192.581	0.000
Khartum. Vost. (E)	Eoc. VI	G	0.7080	0.003343	0.81	--	--	--
Khodzhaosman	L. Cret. XVIII	O	0.6790	--	--	268.690	221.075	0.000
Palvantash	Plioc. I + Olig. III	O	1.0200	--	--	24.446	37.935	0.000
Palvantash	Eoc. IV-VI	GO	0.9490	--	--	33.603	349.566	0.000
Palvantash	Eoc. VII-VIII	GO	0.8490	--	--	72.007	579.924	0.000
Palvantash	U. Cret. XIII+XIV	G	0.6910	0.006776	0.85	--	--	--
Palvantash	L. Cret. XVIIIg	G	0.6900	0.004804	0.79	--	--	--
Palvantash, Zap. (W)	Mioc. bgr	O	1.0900	--	--	135.127	3265.876	0.000
Palvantash, Zap. (W)	Olig. IIIb	O	1.0040	--	--	59.034	572.498	0.000
Palvantash, Zap. (W)	Eoc. V+VI	O	0.9740	--	--	383.721	1363.689	0.000
Palvantash, Zap. (W)	Eoc. VII	O	1.0190	--	--	245.975	474.396	0.000
Palvantash, Zap. (W)	Eoc. VIII-IX	O	1.0650	--	--	393.560	788.919	0.000
Sharikhan-Khodzhiabad	Olig. II-III	O	0.8260	--	--	240.023	1625.402	764.895
Sharikhan-Khodzhiabad	Eoc. V	O	0.7670	--	--	233.884	205.697	0.000
Sharikhan-Khodzhiabad	Eoc. VI	G	0.7670	0.013073	0.79	--	--	--
Sharikhan-Khodzhiabad	Eoc. VII	O	0.8500	--	--	233.884	2420.848	0.000
Sharikhan-Khodzhiabad	Eoc. VIII	GO	0.7600	--	--	480.047	10125.257	0.000
Sharikhan-Khodzhiabad	L. Cret. XIX-XXII	GO	0.6745	--	--	559.974	37073.799	0.000
Sharikhan-Khodzhiabad	Jura. XXIII-XXIX	GO	0.6790	--	--	591.873	9420.306	0.000
Suzak	L. Cret. XIX	G	0.6670	0.004830	0.78	--	--	--
Suzak	L. Cret. XXI	G	0.6670	0.003725	0.82	--	--	--
South Flank - SW of Fergana								
Aksaray	Eoc. VII	G	0.7010	0.012323	0.78	--	--	--
Aksaray	Paleoc. VIII	G	0.7010	0.009977	0.76	--	--	--
Avval'	Eoc. V	O	0.8500	--	--	222.930	1450.215	0.000
Avval', Vost. (E)	Eoc. V	O	0.8500	--	--	190.851	419.216	0.000
Ayritan	Olig. II (III)	GO	0.8260	--	--	209.318	58.528	0.000
Ayritan	Eoc. V	O	0.8500	--	--	228.347	100.226	0.000
Ayritan	Eoc. VII	O	0.8500	--	--	260.104	515.596	257.798
Ayritan	Paleoc. IX	G	0.7010	0.005702	0.78	--	--	--
Beshkent-Togap	Olig. II (III)	O	0.8260	--	--	97.784	519.193	244.326
Chaur-Yarkutan-Chimion	Eoc. IV	O	0.8500	--	--	73.035	330.158	154.074
Chaur-Yarkutan-Chimion	Eoc. V, VI	O	0.8500	--	--	88.005	642.460	321.230
Chongara-Gal'cha	Eoc. IV	GO	0.6880	--	--	1034.061	34993.438	0.000
Chongara-Gal'cha	Eoc. V	G	0.6500	0.023174	0.78	--	--	--
Chongara-Gal'cha	Eoc. VII	G	0.6860	0.022979	0.76	--	--	--
Karagachi-Tamchi	Eoc. IV	O	0.8500	--	--	627.856	33614.428	0.000
Khankyz	Olig. II (III)	O	0.6500	--	--	49.498	178.440	0.000
Khankyz	Eoc. VII	O	0.8500	--	--	48.928	672.824	0.000
Khankyz	L. Cret. XVIII	G	0.7140	0.004053	0.76	--	--	--
Kim (Sel'rokho)	Olig. II (III)	O	0.8260	--	--	192.019	2138.795	1006.492
Kim (Sel'rokho)	Eoc. V	O	0.8500	--	--	237.160	928.445	464.223
Kim (Sel'rokho)	Eoc. VI	O	0.8500	--	--	246.646	4446.186	2223.093

Table A5. Selected Gas Parameter Estimates, by Reservoir for Fields Discovered through 1987, Fergana Basin (English Units) Continued

Field Name	Pay Zone Identification	Petro-leum Type	Gas Gravity (air=1.0)	Initial Gas Formation Volume Factor (cf/scf)	NA Gas Recovery Efficiency (frac)	Initial Gas-Oil Ratio, GOR (scf/stb)	Ultimate Recoverable Primary A-D Gas (MMscf)	Ultimate Recoverable Waterflood A-D Gas (MMscf)
Kim (Sel'rokho)	Eoc. VIa	O	0.8500	--	--	246.646	2456.422	1228.211
Kim (Sel'rokho)	Eoc. VII	O	0.8500	--	--	237.160	2165.557	1082.779
Nefteabad	Olig. II (III)	GO	0.8260	--	--	205.165	725.483	0.000
Obi-Shifo	Olig. II-III	O	0.8260	--	--	192.019	546.386	257.123
Rishtan, Sever. (N)	U. Cret. XIV	G	0.6670	0.015385	0.80	--	--	--
Rishtan, Sever. (N)	U. Cret. XVI + XVII	O	0.6790	--	--	286.276	682.231	341.116
Rishtan, Sever. (N)	L. Cret. XVIIIg	G	0.6670	0.009074	0.80	--	--	--
Rishtan, Sever. (N)	Jura. XXIII-XXIX	G	0.6670	0.006688	0.80	--	--	--
Sarykamysh	U. Cret. XIV	G	0.6670	0.026014	0.82	--	--	--
Sarykamysh	L. Cret. XVII	G	0.6670	0.014229	0.79	--	--	--
Sarykamysh	Jura. XXIII	G	0.6670	0.007613	0.82	--	--	--
Sarytok	Jura. XXVI	G	0.6670	0.007528	0.80	--	--	--
Shorsu IV	Olig. II (III)	O	0.8260	--	--	144.890	273.238	128.583
Shorsu IV	Eoc. IV	O	0.8500	--	--	192.019	195.187	91.853
Shorsu IV	Eoc. V	OG	0.8500	--	--	214.707	73.957	0.000
Shorsu IV	Eoc. VI	O	0.8500	--	--	200.393	214.515	107.257
Shorsu IV	Eoc. VII	O	0.8500	--	--	193.187	274.201	117.515
Shorsu IV	Paleoc. VIII	O	0.8500	--	--	218.649	85.623	36.695
Shorsu IV	Paleoc. IX	O	0.8500	--	--	244.459	188.065	94.032
Shorsu VI	Eoc. VII	G	0.7010	0.031864	0.77	--	--	--
Sokh, Sever. (N)	Olig. II	OG	0.6850	--	--	205.165	2677.828	0.000
Sokh, Sever. (N)	Eoc. IV	GO	0.7100	--	--	190.851	219.224	97.433
Sokh, Sever. (N)	Eoc. V	GC	0.6630	0.006094	0.80	--	--	--
Sokh, Sever. (N)	Eoc. VII	G	0.7010	0.005811	0.80	--	--	--
Sokh, Sever. (N)	Paleoc. VIII	O	0.8500	--	--	237.160	915.460	406.871
Sokh, Sever. (N)	U. Cret. XIV-XV	GO	0.6450	--	--	471.513	2496.278	0.000
Sokh, Sever. (N)	L. Cret. XVIIIg	GC	0.6660	0.005222	0.77	--	--	--
Sokh, Sever. (N)	L. Cret. XXII	GC	0.6480	0.004650	0.79	--	--	--
Sokh, Sever. (N)	Jura. XXIV-XXV	GC	0.6870	0.003752	0.79	--	--	--
Tasravet	Eoc. IV	O	0.8500	--	--	282.908	570.351	240.148
Central Basin Graben								
Achisu	Olig. II (III)	O	0.8260	--	--	426.888	1473.486	0.000
Gumkhana	Plioc. I	O	0.9500	--	--	1000.000	6015.595	0.000
Gumkhana	Mioc.(?)	O	0.9500	--	--	1100.000	15308.599	0.000
Kanibadam	Eoc. V	O	0.7680	--	--	427.580	198.238	0.000
Kanibadam	Eoc. VII	O	0.8500	--	--	432.439	654.231	0.000
Kanibadam	Paleoc. IX+IXa	GC	0.6640	0.003763	0.72	--	--	--
Kanibadam, Sever. (N)	Olig. II (III)	O	0.8260	--	--	503.231	1356.390	0.000
Madaniyat	Olig. II	O	0.8260	--	--	434.670	1407.310	0.000
Madaniyat	Eoc. IV	O	0.8500	--	--	458.818	1433.911	0.000
Madaniyat	Eoc. VII	O	0.8500	--	--	434.670	4188.780	0.000
Makhram	Olig. II-III	O	0.8260	--	--	474.320	906.278	0.000
Mingbulak	Mioc. kkp	O	0.9510	--	--	1312.000	145672.450	0.000
Mingbulak	Olig. III	O	0.9510	--	--	1568.139	50122.942	0.000
Mingbulak	Paleoc. VIII	O	0.9510	--	--	1568.139	34302.557	0.000
Mingbulak	Paleoc. IX	GC	0.7000	0.002570	0.66	--	--	--
Niyazbek-Karakchikum	Olig. II (III)	O	0.8260	--	--	531.263	5075.580	0.000
Niyazbek-Karakchikum	Eoc. IV	O	0.8500	--	--	579.560	3933.416	0.000
Niyazbek-Karakchikum	Eoc. V	O	0.8500	--	--	579.560	1280.507	0.000
Niyazbek-Karakchikum	Eoc. VI	GC	0.7080	0.003046	0.71	--	--	--
Niyazbek-Karakchikum	Eoc. VIIa	GC	0.7010	0.003268	0.69	--	--	--
Niyazbek-Karakchikum	Paleoc. IX	GC	0.7010	0.003265	0.69	--	--	--
Niyazbek-Karakchikum	U. Cret. XI-XII	GC	0.6670	0.003259	0.69	--	--	--
Ravat	Olig. II (III)	O	0.8260	--	--	1630.209	17567.332	0.000
Ravat	Eoc. IV	O	0.8500	--	--	173.244	1308.820	0.000
Ravat	Eoc. V	GC	0.7080	0.003639	0.71	--	--	--
Ravat	Eoc. VII	O	0.6200	--	--	700.130	3127.328	0.000
Ravat	Paleoc. IX-IXa	GC	0.7000	0.002961	0.72	--	--	--

Table A5. Selected Gas Parameter Estimates, by Reservoir for Fields Discovered through 1987, Fergana Basin (English Units) Continued

Field Name	Pay Zone Identification	Petro-leum Type	Gas Gravity (air=1.0)	Initial Gas Formation Volume Factor (cf/scf)	NA Gas Recovery Efficiency (frac)	Initial Gas-Oil Ratio, GOR (scf/stb)	Ultimate Recoverable Primary A-D Gas (MMscf)	Ultimate Recoverable Waterflood A-D Gas (MMscf)
Varyk	Olig. II (III)	O	0.8260	--	--	509.585	3022.101	0.000
Varyk	Eoc. IV	O	0.8500	--	--	708.931	2028.518	0.000
Varyk	Eoc. V	G	0.8500	0.003348	0.69	--	--	--
Varyk	Eoc. VII	O	0.8500	--	--	678.197	2456.187	0.000
Varyk	Paleoc. IX	O	0.8500	--	--	683.881	4923.165	0.000
Varyk II	Olig. II (III)	O	0.8260	--	--	667.818	1691.338	0.000
Varyk II	Eoc. IV	O	0.8500	--	--	711.480	796.907	0.000
Varyk II	Eoc. VII	O	0.8500	--	--	711.480	1271.940	0.000
Total 53 fields and field-combinations	177 reservoirs	121 O-GO-OG 56 G-GC reservoirs					561327.752 MMscf Pri. A-D Gas	22292.644 MMscf Wf. A-D Gas

Notes: At least 7 additional fields exist (1993 Uzbek & Petroconsultants information),which were probably discovered after 1987.

Volumetric calculations used piecemeal data sources and estimates. Some of the most sensitive data to calculations (reservoir area and thickness), were the least reliable. GORs for Gumkhana and Mingbulak fields are other examples of suspect estimates.

Listing of fields in the central basin graben is from Glumakov, et al, 1988; not all are deep-basin.

Initial field discovery year used for all reservoirs in that field.

For Mingbulak field, data listed with 1983* (asterisk) discovery year relate to estimates following the 1992 oil blowout.

Totals may not equal sum of components due to independent rounding. Other calculations also use complete values rather than the rounded values shown.

N-E-S-W as directions of north, east, south, and west.

Pay Zones as Plioc., Mioc., Olig., Eoc., Paleoc. are epochs of Tertiary Period (Pliocene, Miocene, Oligocene, Eocene, Paleocene). U. an L. Cret. are Upper and Lower Cretaceous Epochs. Jura. is Jurassic Period and Permo-Trias. is a composite zone of the Permian-Triassic Periods.

Petroleum Type as that in the reservoir; O = oil, G = natural gas, GC = gas condensate; when GO or OG is listed, the last letter indicates dominance.

Gas Gravity is the specific gas gravity related to air = 1.00.

Units as cf/scf = gas formation factor, cubic feet reservoir gas per standard cubic foot gas; scf/stb = gas-oil ratio as standard cubic feet gas per stock tank barrel oil; MMscf = million standard cubic feet gas. These "standard" units represent surface conditions.

NA Gas = nonassociated (free) gas; frac = decimal fraction; Primary (pri.) = oil recovery mechanism, including liquid expansion; Waterflood (Wf.) = improved oil recovery by waterflood; A-D Gas = associated-and/or-dissolved gas in oil reservoirs or produced with the oil.

Source: Energy Information Administration, Office of Oil and Gas.

Appendix B

Selected Petroleum Engineering Formulas and Relationships

Appendix B

Selected Petroleum Engineering Formulas and Relationships

Formulas Used in Volumetric Calculations [metric units, only]

- Original Oil In Place [OOIP, million surface cubic meters]

$$\textbf{OOIP} = [A * h * \phi * (1 - S_W)] \; / \; B_{oi}$$

where:

A	=	area of reservoir [square kilometers]
h	=	average thickness of net pay [meters]
ϕ	=	average porosity [decimal fraction]
S_w	=	average water saturation [decimal fraction]
B_{oi}	=	initial oil formation volume factor [million cubic meters oil (reservoir) per million surface cubic meters oil].

- Primary Ultimate Recoverable Oil, cm [$PURO_{cm}$, million surface cubic meters]

$$\textbf{PURO}_{\textbf{cm}} = OOIP * [R.E._{pri}]$$

where:

OOIP	=	original oil in place [million surface cubic meters]
$R.E._{pri}$	=	oil recovery efficiency by primary and liquid expansion mechanisms [decimal fraction].

- Primary Ultimate Recoverable Oil, mt [$PURO_{mt}$, million surface metric tons]

$$\textbf{PURO}_{\textbf{mt}} = OOIP * [R.E._{pri}] * D_o$$

where:

OOIP	=	original oil in place [million surface cubic meters]
$R.E._{pri}$	=	oil recovery efficiency by primary and liquid expansion mechanisms [decimal fraction]

D_o = density of oil [million surface metric tons oil per million surface cubic meters oil, or in units of grams per milliliter].

- Oil Recovery Efficiency by Liquid Expansion [for undersaturated reservoirs; decimal fraction; part of R.E. $_{pri,}$ primary recovery efficieny]

$R.E._{ex}$ =

$$[B_{ob} - B_{oi}] / B_{ob}$$

where:

B_{ob} = oil formation volume factor at bubble-point pressure

B_{oi} = oil formation volume factor at initial reserveroir pressure

- Improved Ultimate Recoverable Oil, cm [$IURO_{cm}$, million surface cubic meters]

$$IURO_{cm} = OOIP * [R.E._{imp}]$$

where:

OOIP = original oil in place [million surface cubic meters]

$R.E._{imp}$ = oil recovery efficiency by water-flood mechanisms [decimal fraction; where waterfloods estimated to be applicable, used approximately one-half of $R.E._{pri}$].

- Improved Ultimate Recoverable Oil, mt [$IURO_{mt}$, million surface metric tons]

$$IURO_{mt} = OOIP * [R.E._{imp}] * D_o$$

where:

OOIP = original oil in place [million surface cubic meters]

$R.E._{imp}$ = oil recovery efficiency by waterflood mechanisms [decimal fraction; where waterfloods estimated to be applicable, used approximately one-half of $R.E._{pri}$]

D_o = density of oil [million surface metric tons oil per million surface cubic meters oil, or in units of grams per milliliter].

- Primary Ultimate Recoverable Associated-Dissolved Gas [million surface cubic meters A-D gas]

$$PURG_{A\text{-}D} = [PURO_{mt}] * "GOR"$$

where:

$PURO_{mt}$ = primary ultimate recoverable oil [million surface metric tons]

"GOR" = gas-oil ratio [million standard cubic meters A-D gas per million surface metric tons oil]

Note: Data are inadequate to separate associated-dissolved gas or proportions of free, associated gas in a gas-oil or oil-gas reservoir. Thus, "GOR" was applied for estimating volumes of both associated and dissolved gas.

- Improved Ultimate Recoverable Associated-Dissolved Gas [million surface cubic meters A-D gas]

$$\mathbf{IURG_{A\text{-}D}} = [IURO_{mt}] * "GOR"$$

where:

$IURO_{mt}$ = improved [water flood] ultimate recoverable oil [million surface metric tons]

"GOR" = gas-oil ratio [million surface cubic meters A-D gas per million surface metric tons oil].

- Original Gas In Place, Nonassociated [OGIP, million surface cubic meters NA gas]

$$\mathbf{OGIP} = [A * h * \phi * (1 - S_w)] \ / \ B_{gi}$$

where:

A = area of reservoir [square kilometers]
h = average thickness of net pay [meters]
ϕ = average porosity [decimal fraction]
S_w = average water saturation [decimal fraction]
B_{gi} = initial gas formation volume factor [million cubic meters gas (reservoir) per million surface cubic meters gas].

- Ultimate Recoverable Nonassociated Gas [million surface cubic meters NA gas]

$$\mathbf{URG_{NA}} = OGIP * [R.E._{gas}]$$

where:

OGIP = original gas in place [NA gas, million surface cubic meters]
$R.E._{gas}$ = NA gas recovery efficiency [decimal fraction].

- Nonassociated Gas Recovery Efficiency [$R.E._{gas}$, decimal fraction]

R = . E . g a s

$$[((1/B_{gi})-(1/B_{ga}))\ /\ (1/B_{gi})]-Cd$$

where:

B_{gi} = initial gas formation volume factor [million cubic meters gas (reservoir) per million surface cubic meters gas]

B_{ga} = abandonment gas formation volume factor, i.e., the gas factor at reservoir abandonment pressure [million cubic meters gas (reservoir) per million surface cubic meters gas]

C_d = depth correction for operations [(depth in meters) / (304.8 meters per thousand feet)] $*$ [0.005]. Used to reduce R.E.$_{gas}$ by a correction factor of 0.005 per thousand feet depth.

Miscellaneous Parameter Relationships [metric and English units]

- Nonassociated Gas Formation Volume Factor [B_{ga} or B_{gi}, million cubic meters gas (reservoir) per million surface cubic meters gas, or in units of cubic feet reservoir gas per surface cubic foot gas]

GFVF = $$[0.02829*Z*(T+460)]\ /\ P$$

where:

Z = gas compressibility factor, as defined by Standing-Katz correlation and estimated using the Dranchuk-Purvis-Robinson technique [dimensionless]

T = reservoir temperature [degrees Fahrenheit]

P = gas reservoir pressure, with initial pressure used for B_{gi} calculations and abandonment pressure used for B_{ga} calculations [pounds per square inch, uncorrected for absolute pressure].

- Initial Oil Formation Volume Factor [B_{oi}, for reservoir oil saturated with solution gas (initial reservoir pressure essentially equal to bubblepoint pressure) and with API gravity equal to or less than 30 degrees; Vasquez and Beggs correlation; barrels (reservoir) per surface barrel]

OFVF$_{-30}$ =

$$1+[4.667*(E-04)]*GOR+[1.751*(E-05)]*[T-60]*[API\ /\ G_g]-[1.811*(E-08)]*GOR*[T-60]*[API\ /\ G_g]$$

where:

Same for E, GOR, T, API, and G_g as next below.

- Initial Oil Formation Volume Factor [B_{oi}, for reservoir oil saturated with solution gas (initial reservoir pressure essentially equal to bubblepoint pressure) and with API gravity more than 30 degrees; Vasquez and Beggs correlation; barrels (reservoir) per surface barrel]

OFVF$_{+30}$ =

$$1+[4.670*(E\text{-}04)]*GOR+[1.100*(E\text{-}05)]*[T\text{-}60]*[API\ /\ G_g]+[1.337*(E\text{-}09)]*GOR*[T\text{-}60]*[API\ /\ G_g]$$

where:

E = exponent shown in parenthesis to the base of 10
GOR = gas-oil ratio of dissolved gas [surface cubic feet gas per surface barrel oil]
T = initial reservoir temperature [degrees Fahrenheit]
API = density of oil [degrees API gravity; American Petroleum Institute unit]
G_g = gas gravity related to that of air being 1.0 [decimal fraction].

- Initial Oil Formation Volume Factor [Boi, for reservoir oil <u>undersaturated</u> with solution gas (initial reservoir pressure greater than bubblepoint pressure); Vasquez and Beggs correlation; barrels (reservoir) per surface barrel]

OFVF$_{us}$ =

$$[B_{ob}]*\exp[((5*GOR+17.2*T-1180*G_g+12.61*API-1443)\ /\ (P_i*100000))*(P_b-P_i)]$$

where:

B_{ob} = oil formation factor at bubblepoint pressure [used formation volume factor at saturated conditions; barrels (reservoir) per surface barrel]
exp = exponential to base e follows
GOR = gas-oil ratio of dissolved gas [cubic feet gas per barrel oil]
T = initial reservoir temperature [degrees Fahrenheit]
G_g = gas gravity related to that of air being 1.0 [decimal fraction]
API = density of oil [degrees API gravity; American Petroleum Institute unit]
P_i = initial reservoir pressure [pounds per square inch, assumed for absolute pressure]
P_b = bubblepoint pressure of reservoir oil [pounds per square inch, assumed for absolute pressure].

- Bubblepoint Reservoir Oil Pressure [P_b, with API gravity equal to or less than 30 degrees; Vasquez and Beggs correlation; pounds per square inch]

P$_{b\text{-}30}$ =

$$[(GOR)\ /\ (0.0362*G_g*(\exp((25.724*API)\ /\ (T+460))))]\ \wedge\ [1\ /\ 1.0937]$$

where:

Same for GOR, G_g, exp, API, T, and $\wedge$ as next below.

- Bubblepoint Reservoir Oil Pressure [P_b, with API gravity more than 30 degrees; Vasquez and Beggs correlation; pounds per square inch]

P_{b+30} =

$$[(GOR)\ /\ (0.0178 * G_g * (\exp((23.931 * API)\ /\ (T + 460))))] \wedge [1\ /\ 1.187]$$

where:
- GOR = gas-oil ratio of dissolved gas [surface cubic feet gas per surface barrel oil]
- G_g = gas gravity related to that of air being 1.0 [decimal fraction]
- exp = exponential to base e follows

- API = density of oil [degrees API gravity; American Petroleum Institute unit]
- T = initial reservoir temperature [degrees Fahrenheit]
- ∧ = indicates exponent follows for preceeding base expression.

- Gas Reservoir Abandonment Pressure [P_{abd}, pounds per square inch]

$\mathbf{P_{abd}}$ =

$$[0.1\ psi] * d$$

where:
- psi = pounds per square inch, assumed for absolute pressure
- d = depth in feet.

- Subsurface Pressure from Overall-Basin Gradient Determination [pounds per square inch, assumed absolute pressure]

$$[(0.6735) * d] - 813.2761$$

$\mathbf{P_{sub}}$ =

where:
- d = depth in feet.

- Subsurface Temperature from Overall-Basin Gradient Determination [degrees Fahrenheit]

$$[(0.0121) * d] + 67.7145$$

$\mathbf{T_{sub}}$ =

where:
- d = depth in feet.

- Permeability Categories [used for general characterization of both sandstones and carbonates]

-- "tight" [low permeability] -- equal to or less than 10 millidarcies
-- medium -- above 10 and up through 600 millidarcies
-- more permeable -- above 600 millidarcies.

- Limits for Waterflood Projects
  -- no reservoir deeper than 2,400 meters [7,874 feet]
  -- no reservoir area less than 3 square kilometers [1.16 square miles or 741 acres]
  -- no net pay thickness less than 3 meters [9.8 feet]
  -- no "tight" reservoirs equal to or less than 10 millidarcies permeability.

- Guidelines for Average Thickness of Net Pay [the minimum net pay thickness allowed for inclusion in assessment was 6.6 feet or 2.0 meters]:
  -- Baktria/Massaget formations [Pliocene-Miocene, i.e., Neogene], net pay at 40 percent of gross thickness;
  -- Sumsar formation [Oligocene], net pay at 30 percent of gross thickness;
  -- Khanabad/Lyakan/Alay formations [Eocene], net pay at 35 percent of gross thickness;
  -- Bukhara formation [Paleocene], net pay at 25 percent of gross thickness;
  -- Pestrotsvet/Kyzyl/Lyakan/Muyan formations [Cretaceous], net pay at 40 perent of gross thickness;
  -- Jurassic/Permo-Triassic formations, net pay at 20 percent of gross thickness.

Appendix B Note: Vasquez and Beggs correlations are presented in *Petroleum Engineering Handbook*, 1987, editor-in-chief H.B. Bradley, Society of Petroleum Engineers, Richardson, TX, Chapter 22, p. 10-13.

Appendix C

Correlations Used as Guidelines in Determining Oil and Gas Resources

Appendix C

Correlations Used as Guidelines in Determining Oil and Gas Resources

During the course of this study, it was necessary to develop estimating procedures for determining the values of unreported parameters or resolving conflicting data. These guidelines and correlations were developed from the reported parameters and other standard industry correlations. Correlations could not be developed for every parameter, such as reservoir drive mechanism. In this case, professional judgement or analogies with other fields in the basin were used to estimate the missing values. For the most part, the developed guidelines listed below were used to estimate their respective parameters. Graphical representations of the correlations developed for this study are contained in this appendix.

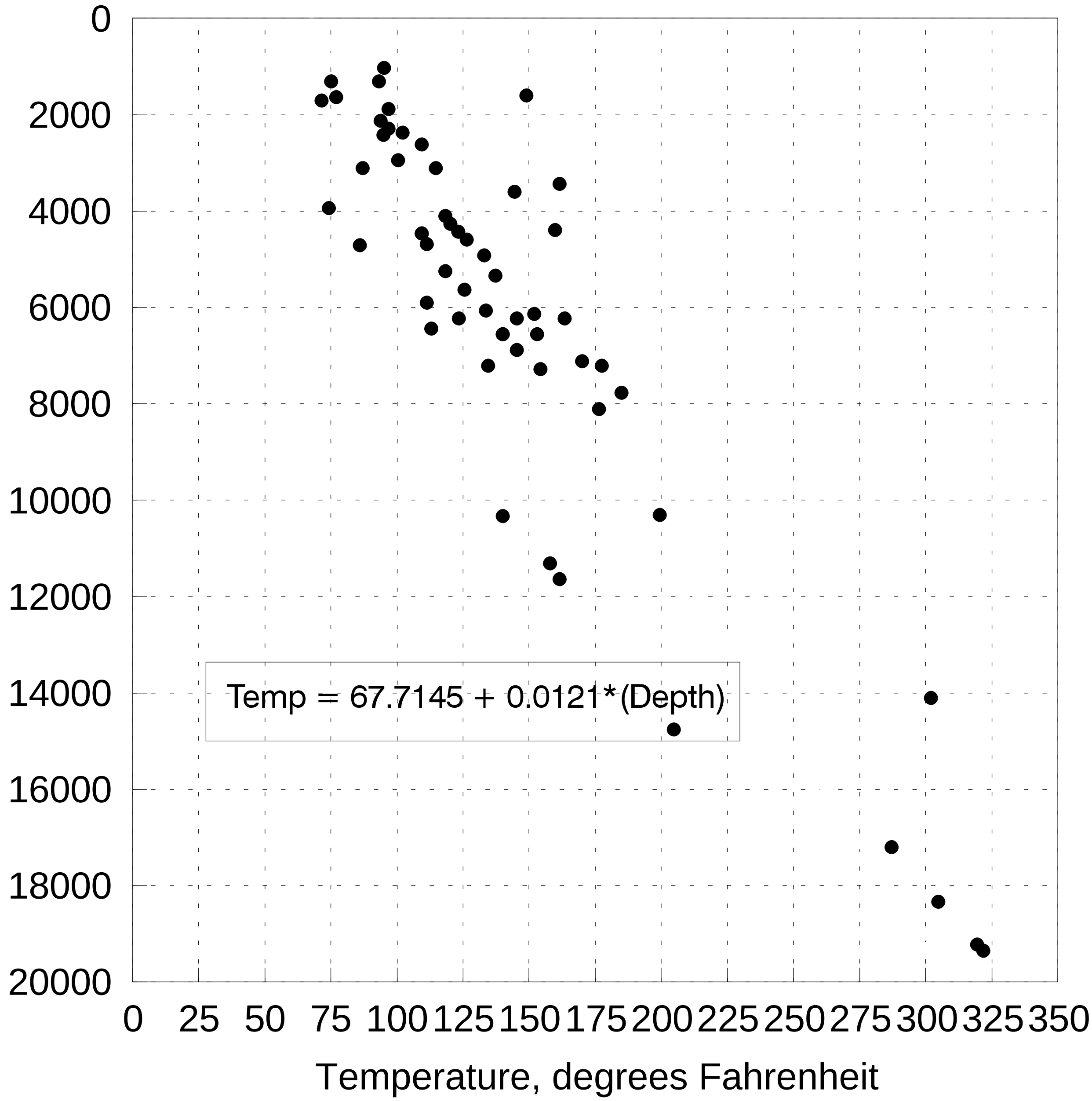
Following is a list of figures depicting the correlations developed for this study.

Both reservoir temperature and pressure are generally related to depth (**Figure C1 and C2**). These correlations were determined by fitting a straight line through the available data. Notice that in **Figure C2**, there seems to be a change in the pressure gradient around 12,000 feet. For reference, a normal pressure gradient of 0.433 pounds per square inch per foot depth (psi/ft) and a twice-normal gradient of 0.866 psi\ft are indicated by the two dashed lines on **Figure C2**. The solid line is a linear fit through the pressure data. This chart indicates the existence of overpressured reservoirs.

The water saturation correlations of **Figure C3** were extrapolated from work done by Elmdahl (1958). Elmdahl provided a range of water saturations based on core analyses of productive reservoirs. Mid-point values from his correlations of porosity, permeability, and water saturation were used to develop **Figure C3**.

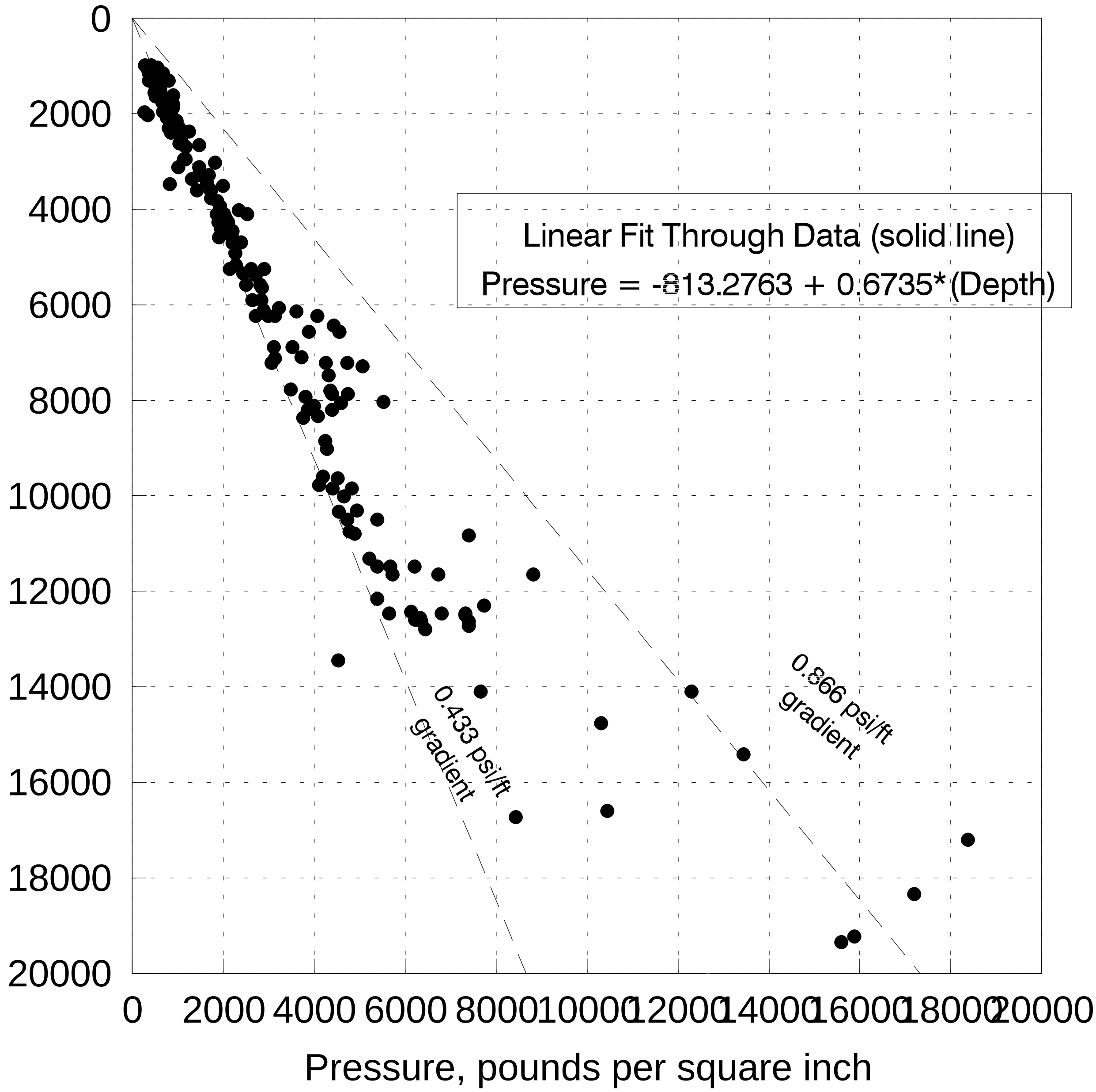
Recovery efficiency is one of the more difficult parameters to estimate. The solution gas drive curves of **Figures C4 and C5** were derived by curve fitting data presented by Arps (1956). The water drive curves were developed by estimating residual oil saturations using correlations found in Frick (1962) and based on oil viscosities determined from the same Arps data. These residual oil saturations were then corrected for lithology (permeability) and reservoir pressure drawdown. For sandstone reservoirs (**Figure C4**), permeabilities of 1,000, 100, and 10 millidarcies were assigned to Arps' respective categories of unconsolidated, consolidated, and highly cemented. For carbonate reservoirs (**Figure C5**), permeabilities of 15 and 2.5 millidarcies were assigned to Arps' respective categories of vugular and fractured.

Figure C1. Temperature Gradient, Fergana Basin (through 1987)



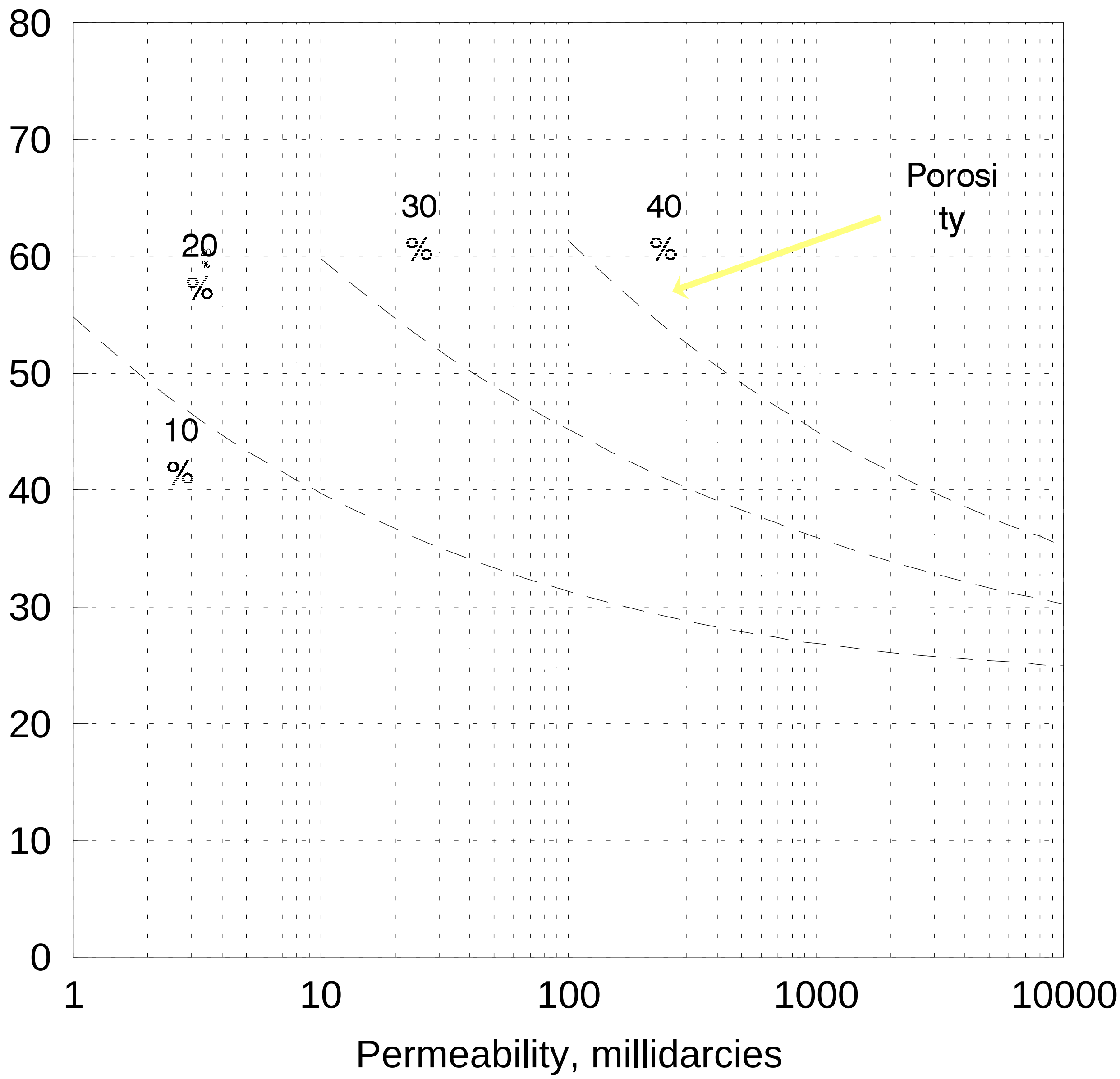
Source: Energy Information Administration, Office of Oil and Gas.

Figure C2. Pressure Gradient, Fergana Basin (through 1987)



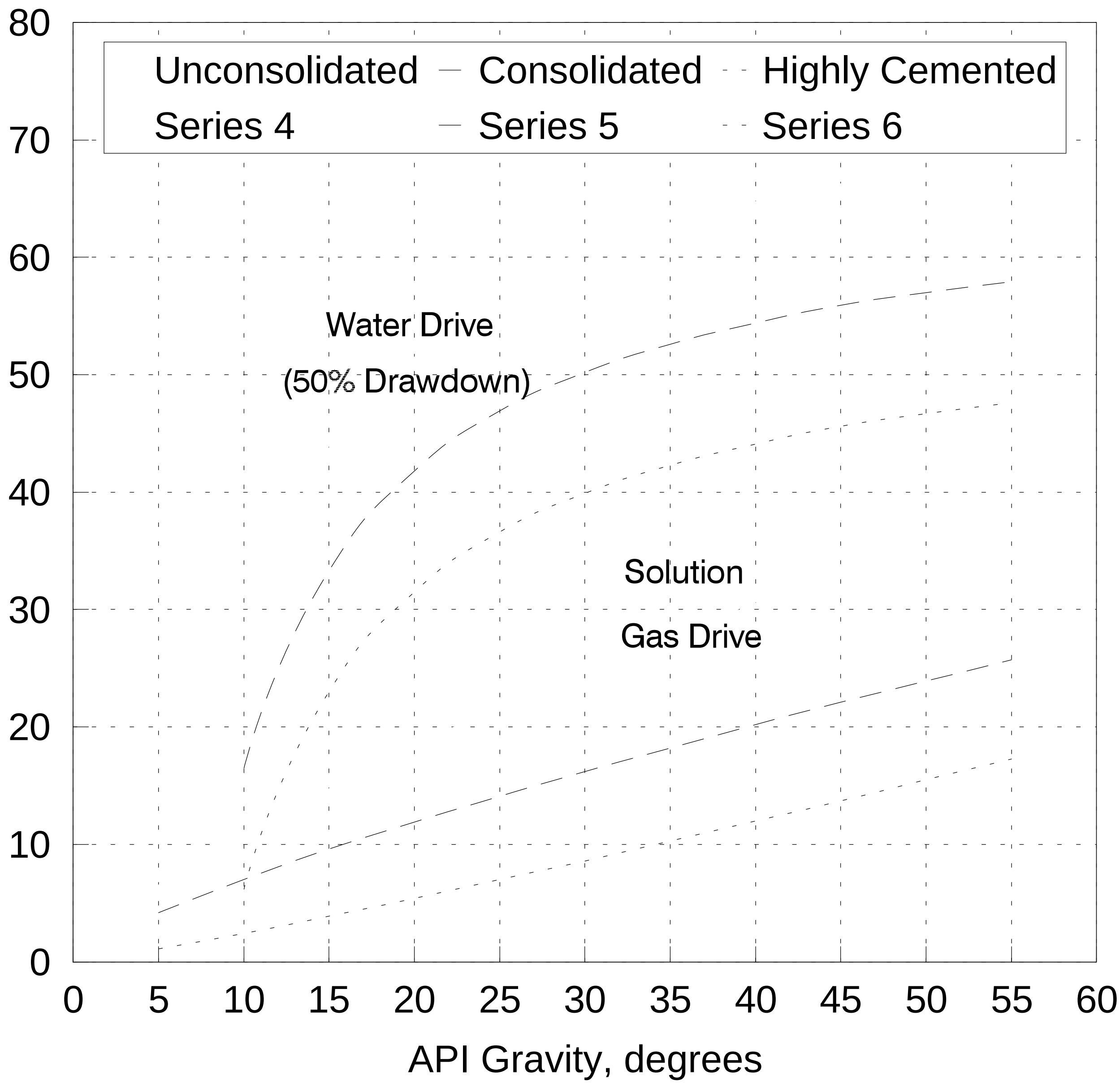
Source: Energy Information Administration, Office of Oil and Gas.

Figure C3. Water Saturation Correlation from Permeability and Porosity for Productive Reservoirs



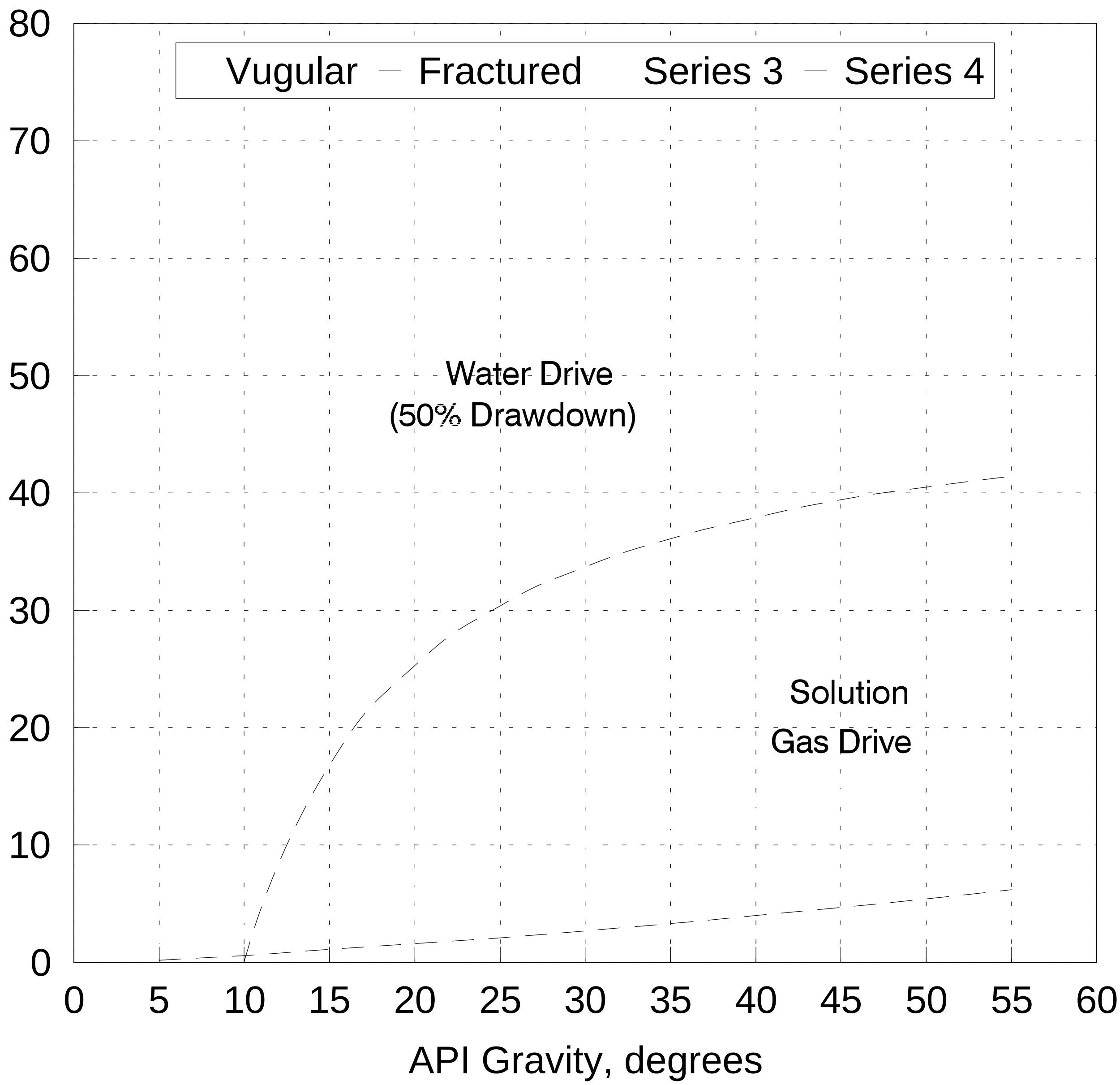
Note: Extrapolated from illustrations presented by Elmdahl (1958).
Source: Energy Information Administration, Office of Oil and Gas.

Figure C4. Oil Recovery Efficiency for Sandstone Reservoirs Under Solution Gas Drive and Water Drive



Note: Derived from data presented by Arps (1956).
Source: Energy Information Administration, Office of Oil and Gas.

Figure C5. Oil Recovery Efficiency for Carbonate Reservoirs Under Solution Gas Drive and Water Drive



Note: Derived from data presented by Arps (1956).
Source: Energy Information Administration, Office of Oil and Gas.

Appendix D

Frequency Distributions of Reservoir and Fluid Parameters

Appendix D

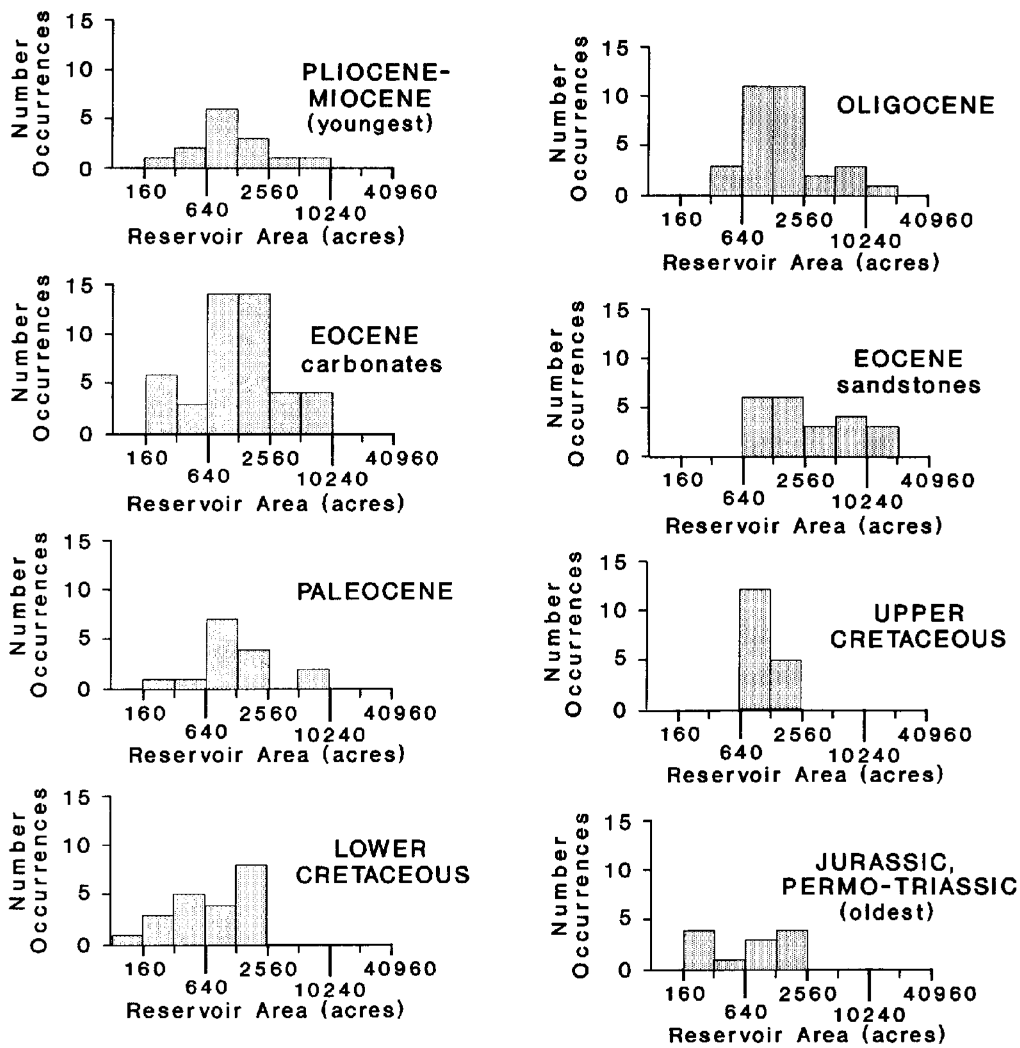
Frequency Distributions of Reservoir and Fluid Parameters

These parameters are the basic elements that are needed for volumetric calculations of recoverable oil and gas. Frequency distribution graphs contained in this appendix were prepared from estimated data for oil and gas discovered through 1987. The data are available in Appendix A or on the available computer diskette.

The reservoir and fluid parameters are separated into reservoir geological age groups, across the basin, and their distributions have broad use for exploration analyses and some development analyses. Also, the distributions have utility in understanding the range of data values estimated and the dominance of values within those ranges. As noted on various following figures in this appendix, some dominant ranges for modal values are primarily a function of data estimation, rather than of reported, measured values.

The following is a list of frequency distribution graphs, with abbreviated titles, contained in Appendix D.

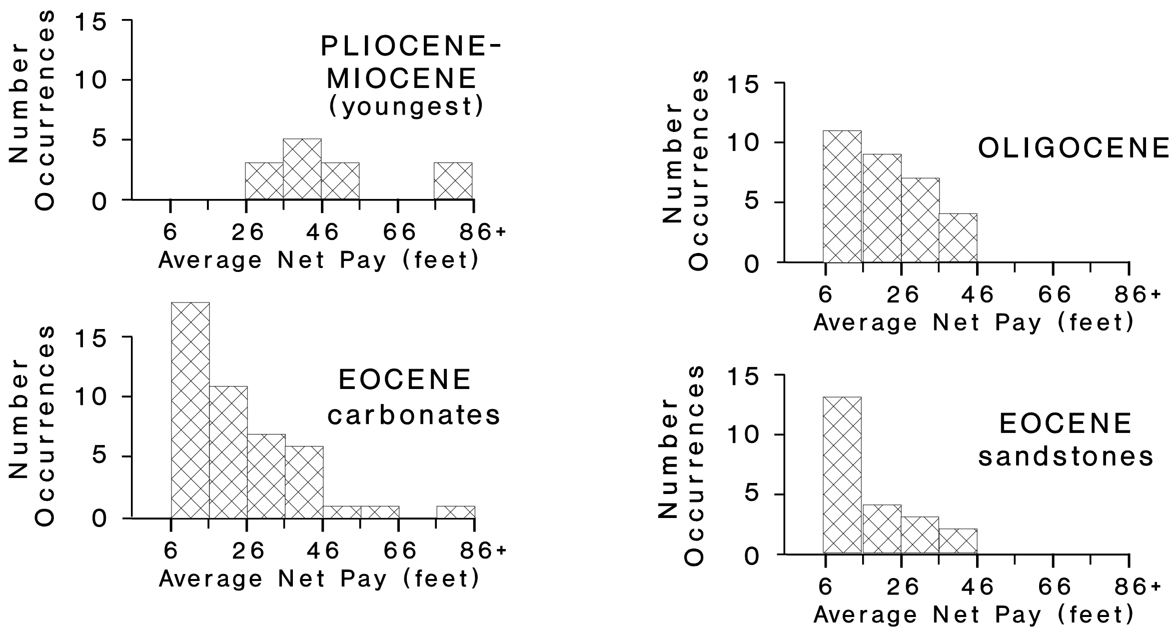
Figure D1. Distribution of Reservoir Area, By Reservoir Geologic Age, Fergana Basin (through 1987)

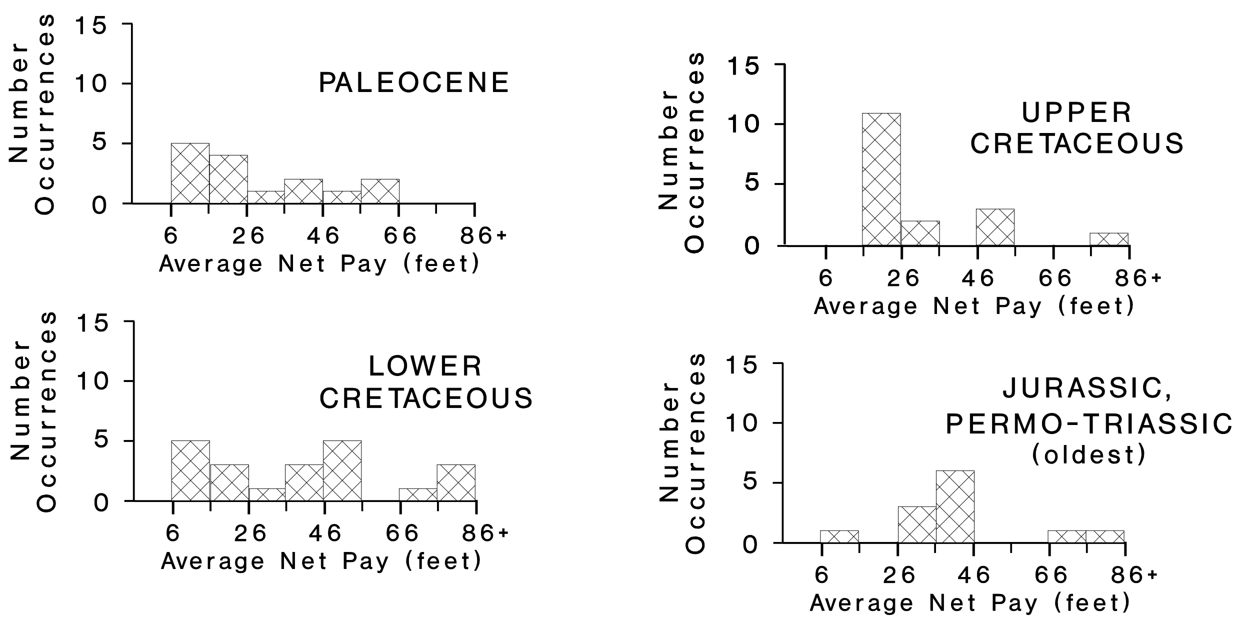


Note: A progressive, doubling horizontal (area) scale is used. The dominant 640-2560 range for most reservoirs is primarily a function of data estimation, rather than of reported measured values. Average reservoir area for the entire basin is 2031.2 acres.

Source: Appendix A.

Figure D2. Distribution of Average Reservoir Net Pay, by Reservoir Geologic Age, Fergana Basin (through 1987)

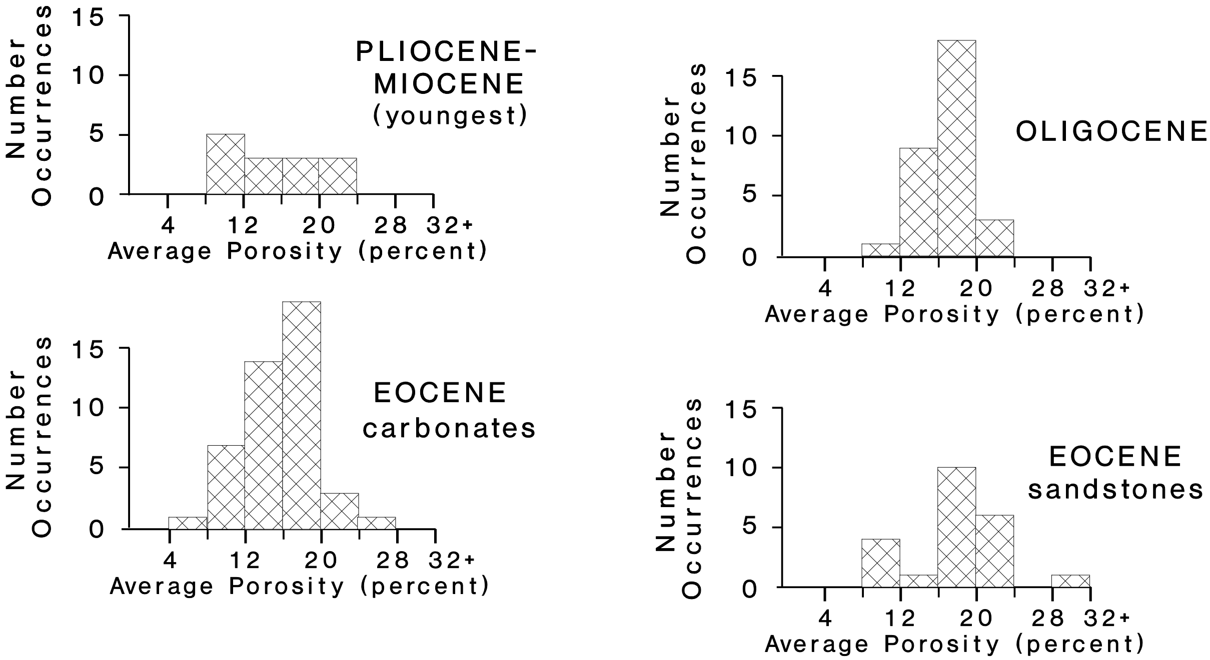


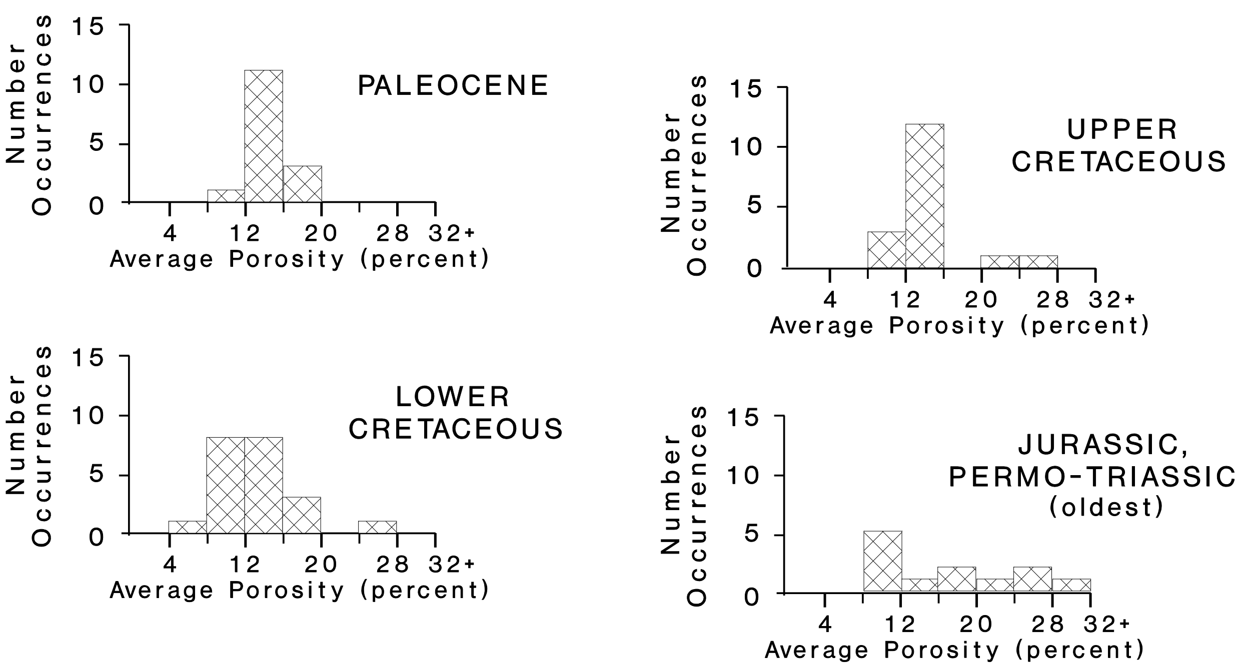


Note: Minimum average net pay (thickness) allowed for inclusion in assessment is 6.6 feet (2 meters). Average reservoir net pay for the entire basin is 29.8 feet.

Source: Appendix A.

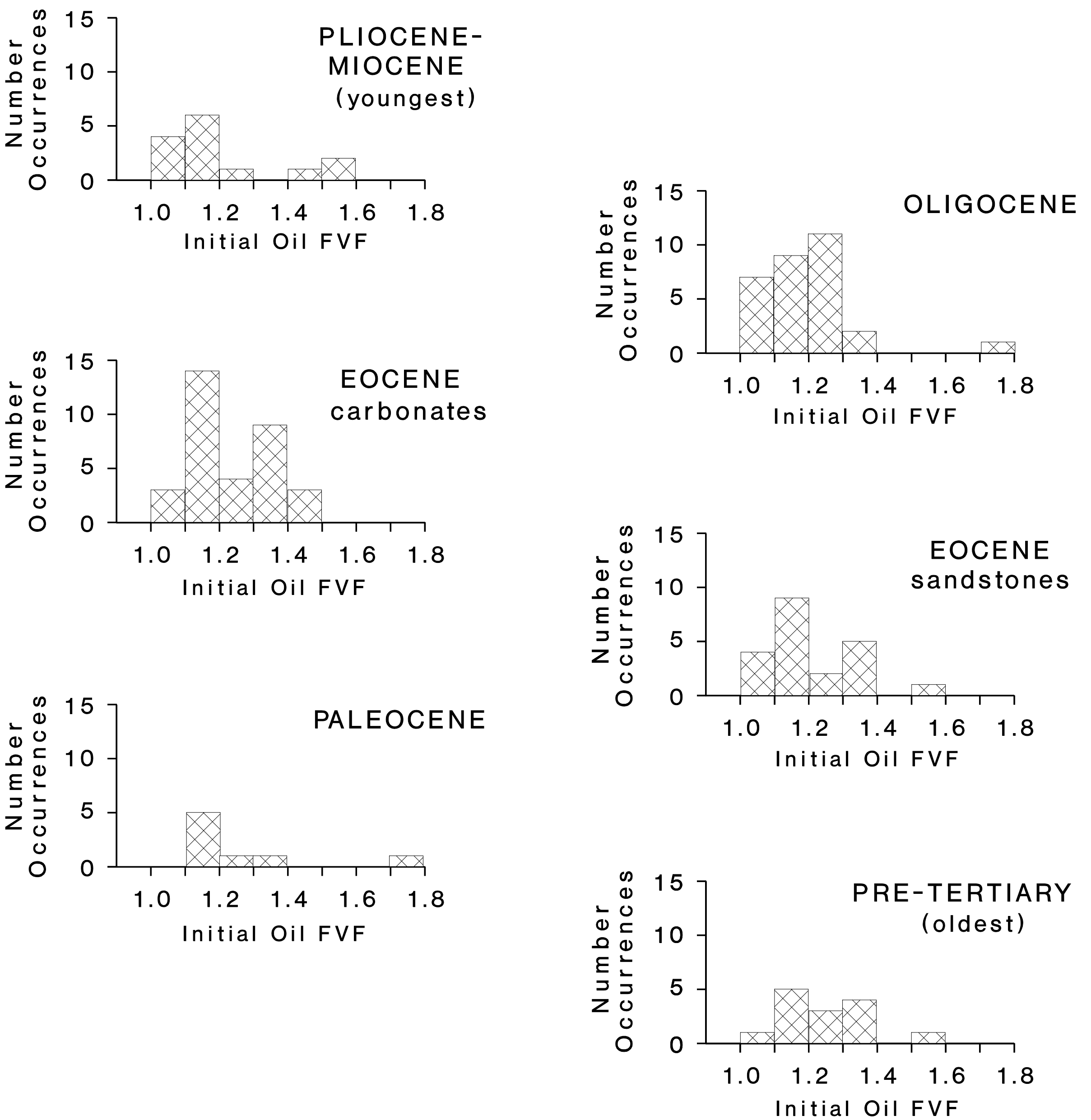
Figure D3. Distribution of Average Reservoir Porosity, by Reservoir Geologic Age, Fergana Basin (through 1987)





Note: Average reservoir porosity for the entire basin is 16.2 percent.
Source: Appendix A.

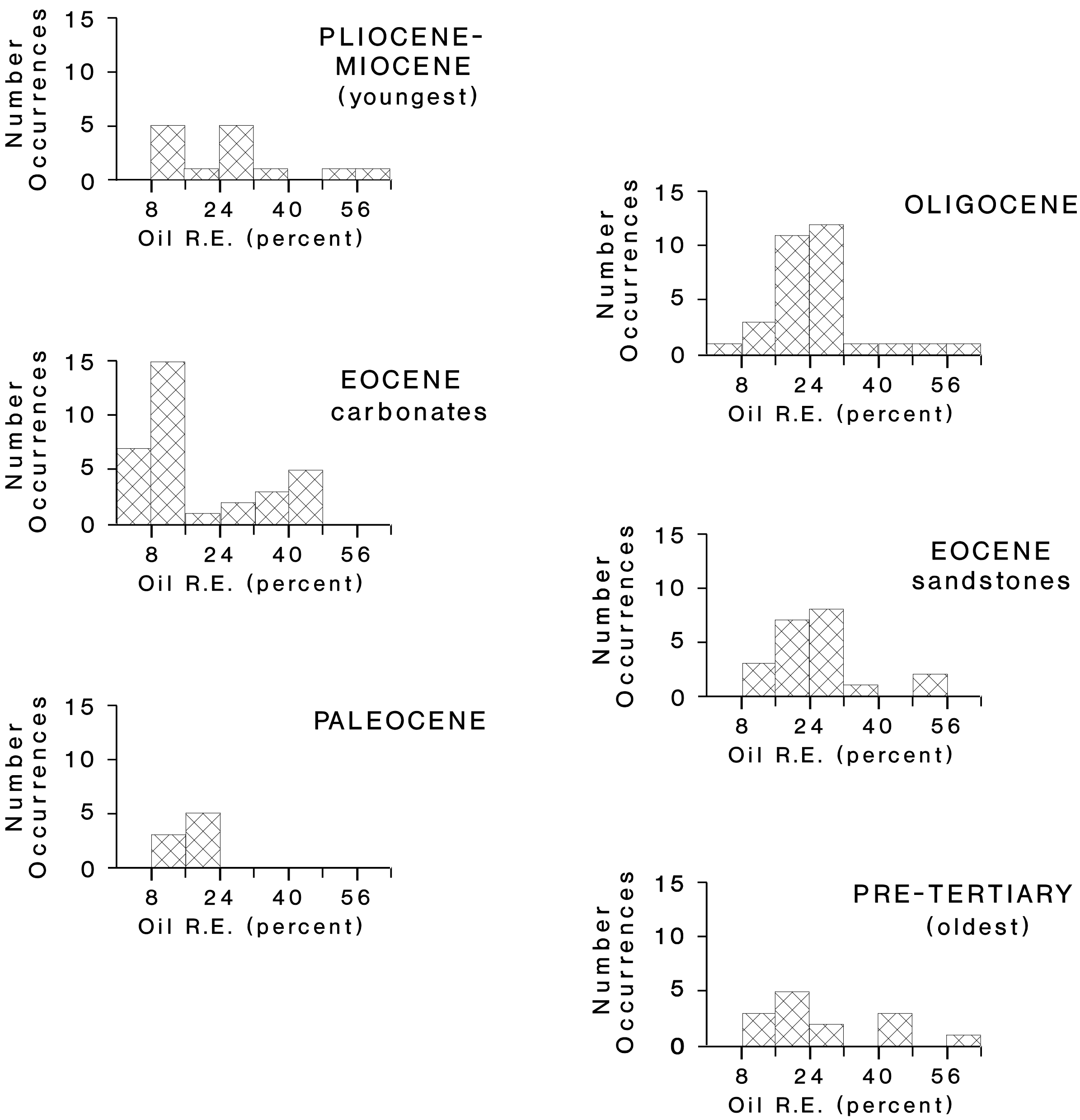
Figure D5. Distribution of Initial Oil Formation Volume Factor, by Reservoir Geologic Age, Fergana Basin (through 1987)



Note: Average initial oil formation volume factor (FVF) for the entire basin is 1.221 (barrels reservoir oil per barrel surface oil).

Source: Appendix A.

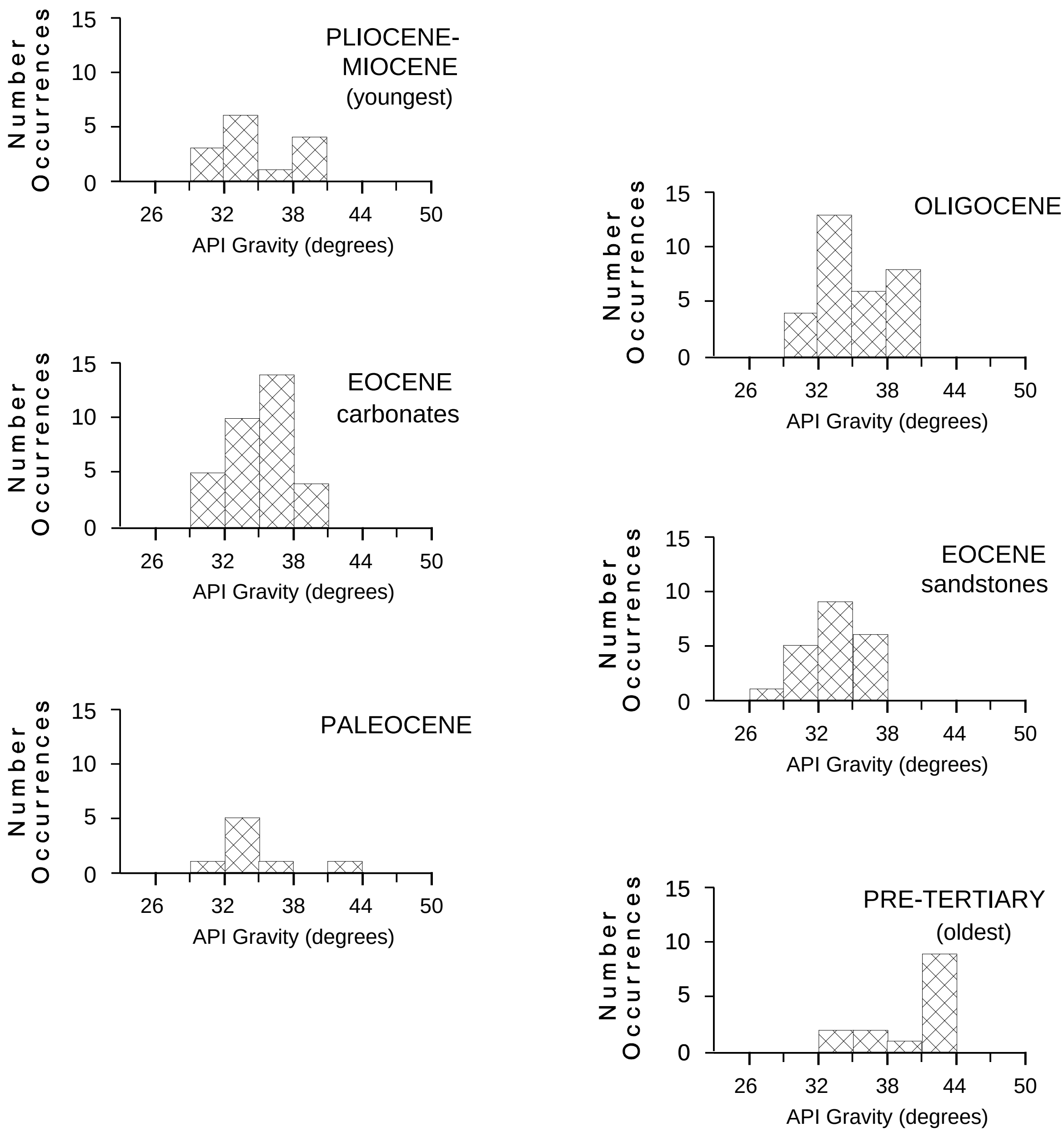
Figure D6. Distribution of Total Oil Recovery Efficiency (R.E.), by Reservoir Geologic Age, Fergana Basin (through 1987)



Note: "Total" oil recovery efficiency consists of normal liquid expansion, typical primary recovery, and some water-flood improved recovery. Average total oil recovery efficiency for entire basin is 23.6 percent.

Source: Appendix A.

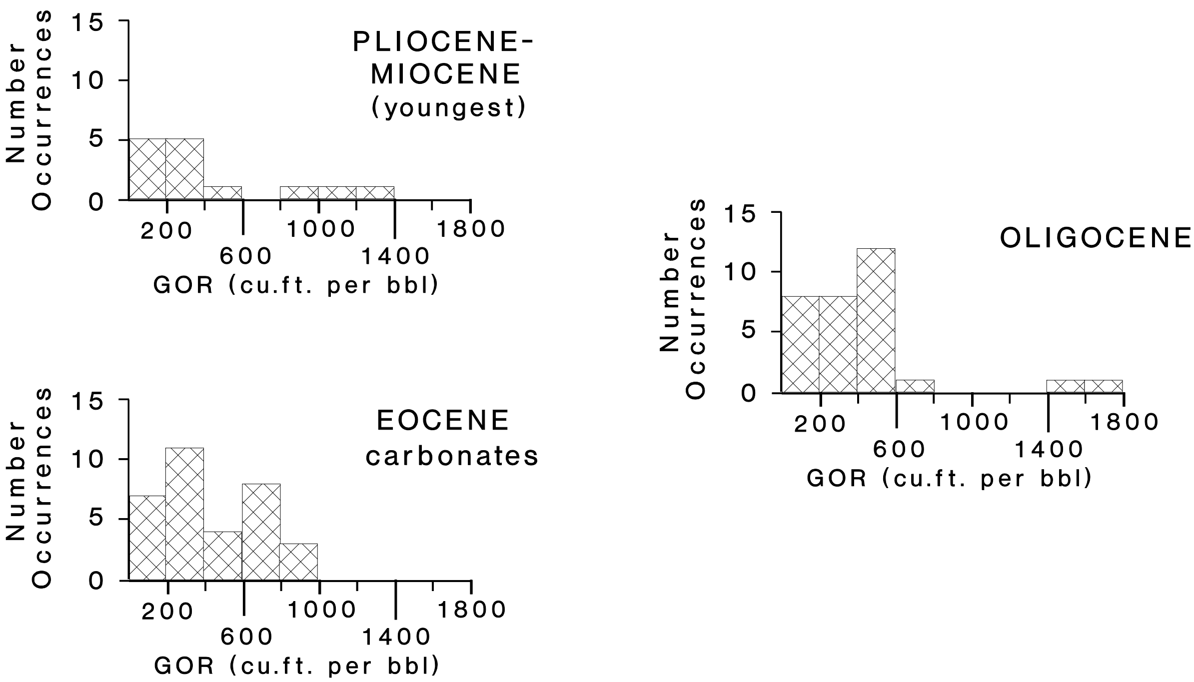
Figure D7. Distribution of Oil Gravity (degrees API), by Reservoir Geologic Age, Fergana Basin (through 1987)

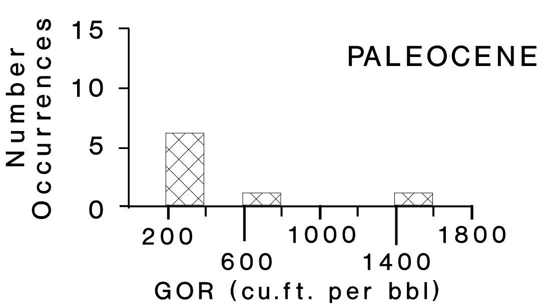


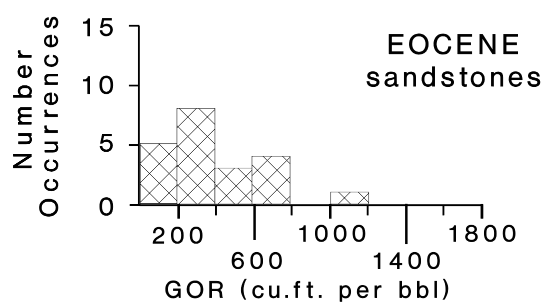
Note: The dominant 29-38 range for Tertiary reservoirs is primarily a function of data estimation, rather than of reported, measured values. Average oil gravity for the entire basin is 35.1 degrees API (a unit of density, American Petroleum Institute).

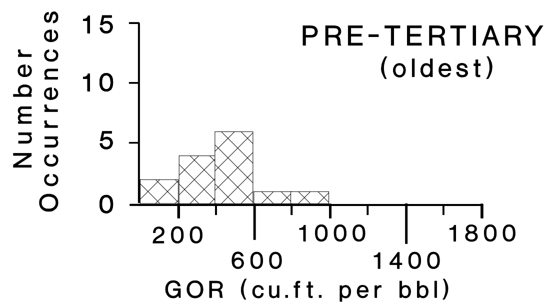
Source: Appendix A.

Figure D8. Distribution of Initial Gas-Oil Ratio (GOR), by Reservoir Geologic Age, Fergana Basin (through 1987)





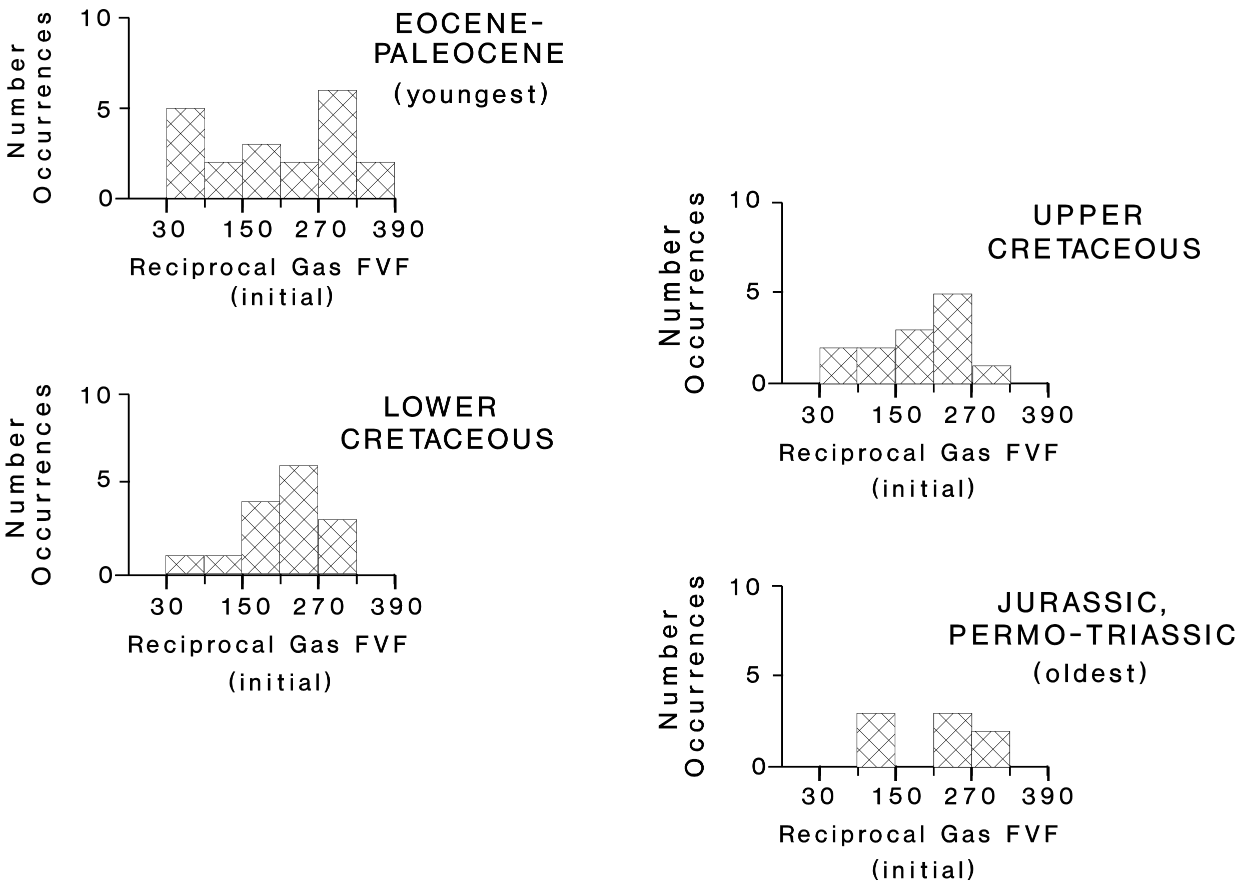




Note: The dominant 0-600 range for most reservoirs is primarily a function of data estimation, rather than of reported, measured values. Average initial gas-oil ratio for the entire basin is 418.8 cubic feet gas per barrel oil (cu.ft. per bbl).

Source: Appendix A.

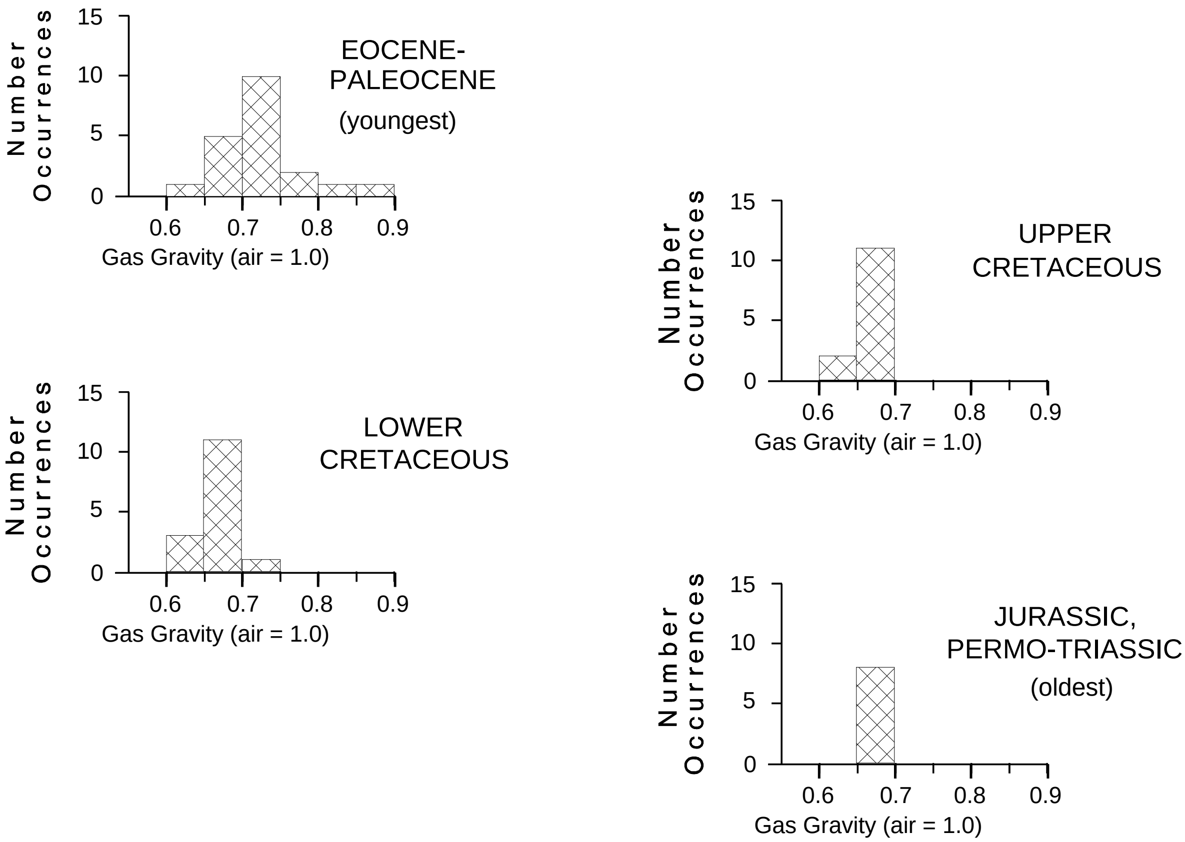
Figure D10. Distribution of Reciprocal Gas Formation Volume Factor by Reservoir Geologic Age, Fergana Basin (through 1987)



Note: No non-associated gas reservoirs determined in strata younger than Eocene. The dominant 90-270 range for pre-Tertiary reservoirs is primarily a function of data estimation, rather than of reported, measured values. Average initial reciprocal gas formation volume factor (FVF) for the entire basin is 207.3 (cubic feet surface gas per cubic foot reservoir gas).

Source: Appendix A.

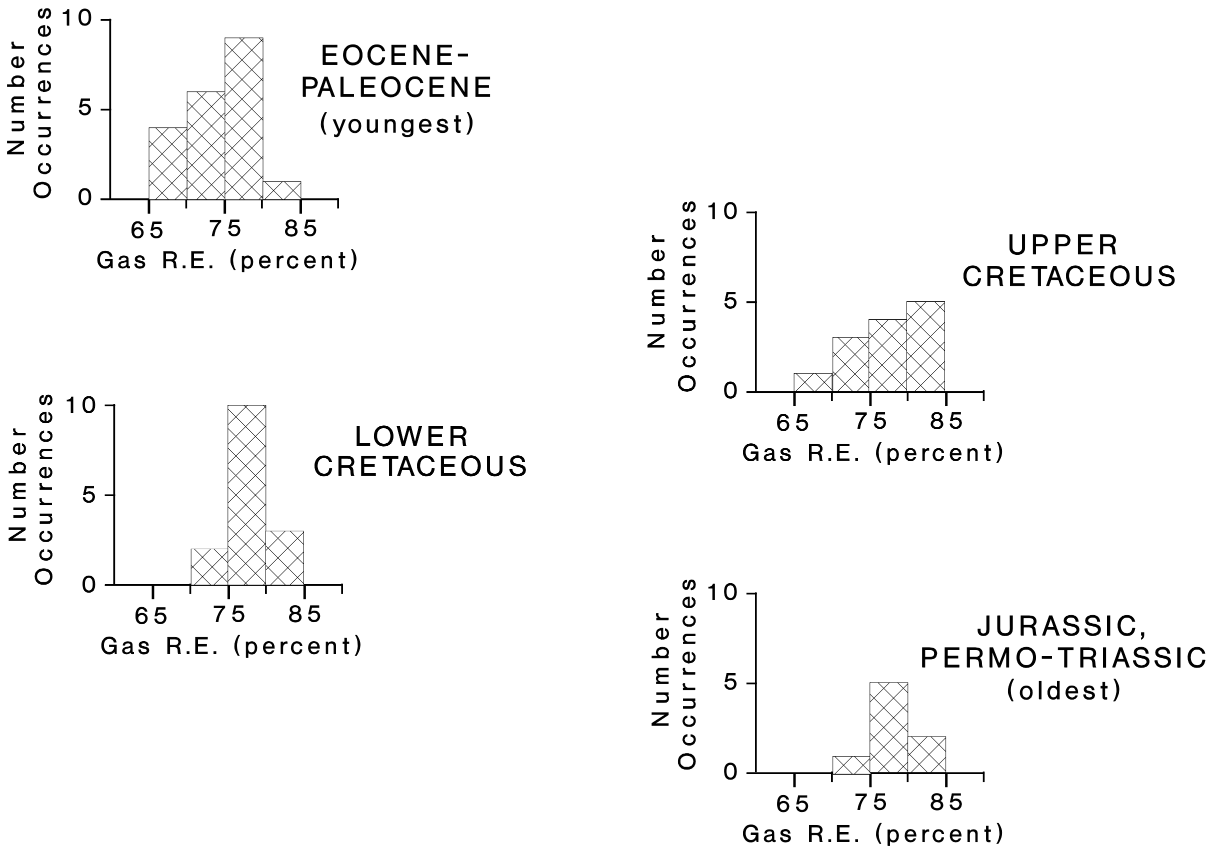
Figure D11. Distribution of Non-associated Gas Gravity, by Reservoir Geologic Age, Fergana Basin (through 1987)



Note: No non-associated gas reservoirs determined in strata younger than Eocene. The dominant 0.65-0.70 range for pre-Tertiary reservoirs is primarily a function of data estimation, rather than of reported, measured values. Average non-associated gas gravity for the entire basin is 0.6844 (relative to air = 1.0).

Source: Appendix A.

Figure D12. Distribution of Non-associated Gas Recovery Efficiency by Reservoir Geologic Age, Fergana Basin (through 1987)



Note: No non-associated gas reservoirs determined in strata younger than Eocene. Average non-associated gas recovery efficiency for the entire basin is 77.2 percent.

Source: Appendix A.

Appendix E

Tabulation of Main Data

(metric units)

Appendix E

Tabulation of Main Data

(metric units)

Following is a list of main data tables, with abbreviated titles, in Appendix E. Metric units are presented here; English units for the same parameters are presented in Appendix A. The available computer diskette also contains these tables as separate files.

Table E1. Basic Information and Estimates, by Reservoir for Fields Discovered through 1987, Fergana Basin (Metric Units)

Republic	Uz Blk	Field Name	Pay Zone Identification	Petro-leum Type	Formation Name	Field Dis-covery Year	Depth (m)	Lith-ology Type	Drive Type
North Basin Flank									
Kyrgyzstan		Bedresay	L. Cret. XVIIIr	G	Layakan	1987?	3000	ms	gd?
Kyrgyzstan		Izbaskent	Olig. II (III)	O	Sumsar	1972	1963	ps	sg
Kyrgyzstan		Izbaskent	Eoc. V-VII	O	Turkestan-Alay	1972	2200	pc	sg
Kyrgyzstan		Izbaskent	Paleoc. IX	O	Bukhara	1972	2378	ps	sg
Kyrgyzstan		Izbaskent	Paleoc. X	O	Bukhara	1972	2400	ms	sg
Kyrgyzstan		Izbaskent	U. Cret. XII	G	Pestrotsvet	1972	2500	ms	gd
Kyrgyzstan		Izbaskent	U. Cret. XIII	G	Pestrotsvet	1972	2539	ps	gd
Kyrgyzstan		Izbaskent	U. Cret. XIV	G	Pestrotsvet	1972	2938	ms	gd
Kyrgyzstan		Izbaskent	U. Cret. XV	G	Pestrotsvet	1972	3052	ms	gd
Kyrgyzstan		Izbaskent	L. Cret. XVIII	G	Layakan	1972	3200	ms	gd
Uzbekistan	1	Kassansay	Olig. II (III)	O	Sumsar	1986?	1700	ms	wd?
Kyrgyzstan		Kyzyl-Alma	Jura. XXIII	G	--	1966	2750	ms	gd?
Kyrgyzstan		Maylisay	Eoc. V	O	Turkestan	1901	500	tc	wd?
Kyrgyzstan		Maylisu III	Olig. II (III)	O	Sumsar	1962	650	ms	sg+wf
Kyrgyzstan		Maylisu III	Eoc. V	O	Turkestan	1962	700	ms	sg+wf
Kyrgyzstan		Maylisu III	Eoc. VII	O	Alay	1962	725	mc	sg+wf
Kyrgyzstan		Maylisu III	U. Cret. XIII	G	Pestrotsvet	1962	810	ps	gd
Kyrgyzstan		Maylisu III	U. Cret. XVII	G	Ustritsa	1962	1223	pc	gd
Kyrgyzstan		Maylisu III	L. Cret. XVIIIa	G	Kyzyl-Pilyal	1962	1250	ps	gd
Kyrgyzstan		Maylisu III	Jura. XXIII	G	--	1962	1870	ps	gd
Kyrgyzstan		Maylisu IV-Izbaskent, Vost. (E)	Mioc. kkp	O	Massaget	1948	1165	ms	sg+wf
Kyrgyzstan		Maylisu IV-Izbaskent, Vost. (E)	Olig. II (III)	O	Sumsar	1948	1200	ts	sg
Kyrgyzstan		Maylisu IV-Izbaskent, Vost. (E)	Eoc. V	O	Turkestan	1948	1250	ts	sg
Kyrgyzstan		Maylisu IV-Izbaskent, Vost. (E)	Eoc. VIIa	O	Alay	1948	1275	ts	sg
Kyrgyzstan		Maylisu IV-Izbaskent, Vost. (E)	Paleoc. IX	O	Bukhara	1948	1300	ms	sg
Kyrgyzstan		Maylisu IV-Izbaskent, Vost. (E)	U. Cret. XIII	GO	Pestrotsvet	1948	1360	ps	sg+wf
Kyrgyzstan		Maylisu IV-Izbaskent, Vost. (E)	U. Cret. XIV	GO	Pesrotsvet	1948	1430	ps	sg+wf
Kyrgyzstan		Maylisu IV-Izbaskent, Vost. (E)	U. Cret. XV	G	Yalovach	1948	1600	ps	gd
Kyrgyzstan		Maylisu IV-Izbaskent, Vost. (E)	U. Cret. XVI	G	Ustritsa	1948	1641	ms	gd
Kyrgyzstan		Maylisu IV-Izbaskent, Vost. (E)	U. Cret. XVII	G	Ustritsa	1948	1719	ps	gd
Kyrgyzstan		Maylisu IV-Izbaskent, Vost. (E)	L. Cret. XVIII	GC	Lyakan	1948	1850	ps	gd
Kyrgyzstan		Maylisu IV-Izbaskent, Vost. (E)	L. Cret. XIX	G	Muyan	1948	2000	ms	gd
Kyrgyzstan		Maylisu IV-Izbaskent, Vost. (E)	L. Cret. XXII	G	Muyan	1948	2200	ms	gd
Kyrgyzstan		Maylisu IV-Izbaskent, Vost. (E)	Jura. XXIII	G	--	1948	2280	ps	gd
Uzbekistan	1	Namangan	Eoc. V	O	Turkestan	1959	3550	mc	gd?
Uzbekistan	1	Shorbulak	Eoc. V	O	Turkestan	1973	3850	tc	wd?
Uzbekistan	1	Tergachi	Mioc. kkp	O	Massaget	1978	3300	ms	wd?
Uzbekistan	1	Tergachi	Eoc. V	O	Turkestan	1978	4300	tc	wd?
South Flank - NE of Fergana									
Uzbekistan	5	Alamyshik, Sever. (N)	Olig. II (III)	O	Sumsar	1973	2450	ms	sg
Uzbekistan	5	Alamyshik, Yuzh. (S)	Plioc. I+Ia	O	Baktria	1945	440	pc	sg+wf
Uzbekistan	5	Alamyshik, Yuzh. (S)	Plioc. Ib	O	Baktria (?)	1945	450	ps	sg+wf
Uzbekistan	5	Alamyshik, Yuzh. (S)	Mioc. Ic	O	Massaget	1945	540	ms	sg+wf
Uzbekistan	5	Alamyshik, Yuzh. (S)	Olig. II (III)	O	Sumsar	1945	550	ms	sg+wf
Uzbekistan	5	Alamyshik, Yuzh. (S)	Eoc. V-VII	O	Turkestan-Alay	1945	595	mc	sg+wf
Uzbekistan	5	Alamyshik, Yuzh. (S)	L. Cret. XVIII	O	Kyzyl-Pilyal	1945	1100	ms	sg
Uzbekistan	5	Alamyshik, Yuzh. (S)	L. Cret. XIX-XXII	O	Muyan	1945	1360	ms	sg
Uzbekistan	5	Alamyshik, Yuzh. (S)	Jura. XXIII	GO	--	1945	1600	ps	sg
Uzbekistan	5	Andizhan	Plioc. I	GO	Massaget	1935	332	ps	sg
Uzbekistan	5	Andizhan	Olig. III	GO	Sumsar	1935	635	ms	gc
Uzbekistan	5	Andizhan	Eoc. V	GO	Turkestan	1935	730	pc	sg+gc
Uzbekistan	5	Andizhan	Eoc. VI	GO	Turkestan	1935	800	pc	sg+gc
Uzbekistan	5	Andizhan	Eoc. VII	GO	Alay	1935	900	pc	sg+gc
Uzbekistan	5	Andizhan	Paleoc. VIII	G	Bukhara	1935	950	pc	gd?
Uzbekistan	5	Boston	Plioc. I	O	Baktria	1952	350	ms	sg+wf
Uzbekistan	5	Boston	Mioc. Ia	O	Massaget	1952	400	ms	sg+wf
Uzbekistan	5	Boston	Mioc. I	O	Massaget	1952	475	ms	sg+wf

Table E1. Basic Information and Estimates, by Reservoir for Fields Discovered through 1987, Fergana Basin (Metric Units) Continued

Republic	Uz Blk	Field Name	Pay Zone Identification	Petro-leum Type	Formation Name	Field Dis-covery Year	Depth (m)	Lith-ology Type	Drive Type
Uzbekistan	5	Boston	Olig. II (III)	O	Sumsar	1952	520	ms	sg+wf
Uzbekistan	5	Boston	Olig. III	O	Sumsar	1952	700	ms	sg+wf
Uzbekistan	5	Boston	L. Cret. XIX	G	Muyan	1952	2000	ms	gd?
Uzbekistan	5	Boston	L. Cret. XX+XXI+XXII	GO	Muyan	1952	2100	ms	sg?
Uzbekistan	5	Boston	Jura. XXVII	G	--	1952	2400	ms	gd?
Uzbekistan	5	Boston	Permo-Trias. XXX	O	--	1952	2700	ts	sg?
Kyrgyzstan		Changyrtash	Olig. III	O	Sumsar	1932	490	ms	sg+wf
Kyrgyzstan		Changyrtash	Eoc. V	O	Turkestan	1932	550	mc	sg+wf
Kyrgyzstan		Chigirchik	Jura. XXIII	O	--	1976	1000	ms	wd?
Uzbekistan	5	Khartum	Olig. III	O	Sumsar	1957	2162	ms	sg
Uzbekistan	5	Khartum	Eoc. VI	O	Turkestan	1957	2500	tc	wd+gd?
Uzbekistan	5	Khartum	Eoc. VII	G	Alay	1957	2550	mc	gd?
Uzbekistan	5	Khartum	L. Cret. XXII	GO	Muyan	1957	4100	ts	sg?
Uzbekistan	5	Khartum, Vost. (E)	Olig. II-III	O	Sumsar	1984	2000	ms	wd+gd
Uzbekistan	5	Khartum. Vost. (E)	Eoc. VI	G	Turkestan	1984	2220	mc	wd+gd
Uzbekistan	5	Khodzhaosman	L. Cret. XVIII	O	Lyakan	1956	575	ms	sg
Uzbekistan	2	Palvantash	Plioc. I + Olig. III	O	Baktria + Sumsar	1943	350	ts	wd
Uzbekistan	2	Palvantash	Eoc. IV-VI	GO	Khanabad-Turkestan	1943	585	ms	wd+gd
Uzbekistan	2	Palvantash	Eoc. VII-VIII	GO	Alay-Bukhara	1943	820	pc	wd+gd
Uzbekistan	2	Palvantash	U. Cret. XIII+XIV	G	Pestrotsvet	1943	920	mc	wd+gd
Uzbekistan	2	Palvantash	L. Cret. XVIIIr	G	Lyakan	1943	1800	ms	wd+gd
Uzbekistan	2	Palvantash, Zap. (W)	Mioc. brp	O	Massaget	1955	1400	ms	wd
Uzbekistan	2	Palvantash, Zap. (W)	Olig. IIIb	O	Sumsar	1955	1900	ms	wd
Uzbekistan	2	Palvantash, Zap. (W)	Eoc. V+VI	O	Turkestan	1955	2170	ms	wd
Uzbekistan	2	Palvantash, Zap. (W)	Eoc. VII	O	Alay	1955	2200	pc	wd
Uzbekistan	2	Palvantash, Zap. (W)	Eoc. VIII-IX	O	Bukhara	1955	2370	mc	wd
Uzbekistan	5	Sharikhan-Khodzhiabad	Olig. II-III	O	Sumsar	1948	520	ms	sg+wf
Uzbekistan	5	Sharikhan-Khodzhiabad	Eoc. V	O	Turkestan	1948	655	pc	sg+wd
Uzbekistan	5	Sharikhan-Khodzhiabad	Eoc. VI	G	Turkestan	1948	690	pc	gd
Uzbekistan	5	Sharikhan-Khodzhiabad	Eoc. VII	O	Alay	1948	740	pc	sg+wd
Uzbekistan	5	Sharikhan-Khodzhiabad	Eoc. VIII	GO	Bukhara	1948	1050	mc	wd
Uzbekistan	5	Sharikhan-Khodzhiabad	L. Cret. XIX-XXII	GO	Muyan	1948	1900	ms	wd
Uzbekistan	5	Sharikhan-Khodzhiabad	Jura. XXIII-XXIX	GO	--	1948	2417	ts	wd
Kyrgyzstan		Suzak	L. Cret. XIX	G	Muyan	1969	1863	ms	gd?
Kyrgyzstan		Suzak	L. Cret. XXI	G	Muyan	1969	1900	ms	gd?
South Flank - SW of Fergana									
Uzbekistan?	4?	Aksaray	Eoc. VII	G	Alay	1985?	765	mc	gd?
Uzbekistan?	4?	Aksaray	Paleoc. VIII	G	Bukhara	1985?	1025	mc	gd?
Uzbekistan	3	Avval'	Eoc. V	O	Turkestan	1955	900	ms	wd?
Uzbekistan	3	Avval', Vost. (E)	Eoc. V	O	Turkestan	1954	1100	mc	wd?
Tadzhikistan		Ayritan	Olig. II (III)	GO	Sumsar	1967	1250	ts	sg?
Tadzhikistan		Ayritan	Eoc. V	O	Turkestan	1967	1340	tc	sg?
Tadzhikistan		Ayritan	Eoc. VII	O	Alay	1967	1435	mc	sg+wf
Tadzhikistan		Ayritan	Paleoc. IX	G	Bukhara	1967	1575	ms	gd?
Kyrgyzstan		Beshkent-Togap	Olig. II (III)	O	Sumsar	1976	1600	ms	sg+wf
Uzbek/Kyrgyz	3p	Chaur-Yarkutan-Chimion	Eoc. IV	O	Khanabad	1904	300	ms	sg+wf
Uzbek/Kyrgyz	3p	Chaur-Yarkutan-Chimion	Eoc. V, VI	O	Turkestan	1904	350	ms	sg+wf
Uzbek/Kyrgyz	4p	Chongara-Gal'cha	Eoc. IV	GO	Khanabad	1949	400	ps	sg+gc
Uzbek/Kyrgyz	4p	Chongara-Gal'cha	Eoc. V	G	Turkestan	1949	420	pc	gd
Uzbek/Kyrgyz	4p	Chongara-Gal'cha	Eoc. VII	G	Alay	1949	460	mc	gd
Tadzhikistan		Karagachi-Tamchi	Eoc. IV	O	Khanabad	1974	2455	ps	sg?
Uzbekistan	3	Khankyz	Olig. II (III)	O	Sumsar	1957	1360	ts	wd
Uzbekistan	3	Khankyz	Eoc. VII	O	Alay	1957	1700	ms	wd
Uzbekistan	3	Khankyz	L. Cret. XVIII	G	Kalachin(?)-Kyzyl-Pilyal	1957	2475	ms	gd
Tadzhikistan		Kim (Sel'rokho)	Olig. II (III)	O	Sumsar	1908	600	ps	sg+wf
Tadzhikistan		Kim (Sel'rokho)	Eoc. V	O	Turkestan	1908	620	mc	sg+wf
Tadzhikistan		Kim (Sel'rokho)	Eoc. VI	O	Turkestan	1908	640	ms	sg+wf
Tadzhikistan		Kim (Sel'rokho)	Eoc. VIa	O	Turkestan	1908	650	ms	sg+wf
Tadzhikistan		Kim (Sel'rokho)	Eoc. VII	O	Alay	1908	670	mc	sg+wf

Table E1. Basic Information and Estimates, by Reservoir for Fields Discovered through 1987, Fergana Basin (Metric Units) Continued

Republic	Uz Blk	Field Name	Pay Zone Identification	Petroleum Type	Formation Name	Field Discovery Year	Depth (m)	Lithology Type	Drive Type
Tadzhikistan		Nefteabad	Olig. II (III)	GO	Sumsar	1933	1060	ts	sg?
Uzbekistan?	3?	Obi-Shifo	Olig. II-III	O	Sumsar	1982?	700	ms	sg+wf
Kyrgyzstan		Rishtan, Sever. (N)	U. Cret. XIV	G	Pestrotsvet	1954	575	ps	gd?
Kyrgyzstan		Rishtan, Sever. (N)	U. Cret. XVI + XVII	O	Ustritsa	1954	723	ms	sg+wf
Kyrgyzstan		Rishtan, Sever. (N)	L. Cret. XVIIIr	G	Lyakan	1954	950	pc	gd?
Kyrgyzstan		Rishtan, Sever. (N)	Jura. XXIII-XXIX	G	--	1954	1250	ms	gd?
Kyrgyzstan		Sarykamysh	U. Cret. XIV	G	Pestrotsvet	1955	315	ms	gd?
Kyrgyzstan		Sarykamysh	L. Cret. XVIIr	G	Lyakan	1955	650	mc	gd?
Kyrgyzstan		Sarykamysh	Jura. XXIII	G	--	1955	1000	ms	gd?
Kyrgyzstan		Sarytok	Jura. XXVI	G	--	1963	1150	ms	gd?
Uzbekistan	4	Shorsu IV	Olig. II (III)	O	Sumsar	1927	300	ms	sg+wf
Uzbekistan	4	Shorsu IV	Eoc. IV	O	Khanabad	1927	325	ps	sg+wf
Uzbekistan	4	Shorsu IV	Eoc. V	OG	Turkestan	1927	350	pc	sg?
Uzbekistan	4	Shorsu IV	Eoc. VI	O	Turkestan	1927	400	ms	sg+wf
Uzbekistan	4	Shorsu IV	Eoc. VII	O	Alay	1927	420	mc	sg+wf
Uzbekistan	4	Shorsu IV	Paleoc. VIII	O	Bukhara	1927	450	mc	sg+wf
Uzbekistan	4	Shorsu IV	Paleoc. IX	O	Bukhara	1927	500	ms	sg+wf
Uzbekistan	4	Shorsu VI	Eoc. VII	G	Alay	1986?	320	mc	gd?
Uzbekistan	4	Sokh, Sever. (N)	Olig. II	OG	Sumsar	1956	1070	ms	sg
Uzbekistan	4	Sokh, Sever. (N)	Eoc. IV	GO	Khanabad	1956	1300	mc	sg+wf
Uzbekistan	4	Sokh, Sever. (N)	Eoc. V	GC	Turkestan	1956	1350	mc	gd
Uzbekistan	4	Sokh, Sever. (N)	Eoc. VII	G	Alay	1956	1400	mc	sg
Uzbekistan	4	Sokh, Sever. (N)	Paleoc. VIII	O	Bukhara	1956	1500	mc	sg+wf
Uzbekistan	4	Sokh, Sever. (N)	U. Cret. XIV-XV	GO	Pestrotsvet	1956	1630	ts	gd
Uzbekistan	4	Sokh, Sever. (N)	L. Cret. XVIIIr	GC	Lyakan	1956	1800	ps	gd
Uzbekistan	4	Sokh, Sever. (N)	L. Cret. XXII	GC	Muyan	1956	1900	ms	gd
Uzbekistan	4	Sokh, Sever. (N)	Jura. XXIV-XXV	GC	--	1956	2100	ms	gd
Uzbekistan	4	Tasravet	Eoc. IV	O	Khanabad	1983?	800	ms	sg+wf
Central Basin Graben									
Uzbekistan	4	Achisu	Olig. II (III)	O	Sumsar	1979	3500	ms	sg?
Uzbekistan	2	Gumkhana	Plioc. I	O	Baktria	1976	4300	ms	sg?
Uzbekistan	2	Gumkhana	Mioc. (?)	O	Massaget(?)	1976	4700	ms	sg?
Tadzhikistan		Kanibadam	Eoc. V	O	Turkestan	1966	2980	mc	sg
Tadzhikistan		Kanibadam	Eoc. VII	O	Alay	1966	3000	mc	sg
Tadzhikistan		Kanibadam	Paleoc. IX+IXa	GC	Bukhara	1966	3142	ps	gd
Tadzhikistan		Kanibadam, Sever. (N)	Olig. II (III)	O	Sumsar	1970	2925	ms	sg
Tadzhikistan		Madaniyat	Olig. II	O	Sumsar	1978	3800	ms	sg?
Tadzhikistan		Madaniyat	Eoc. IV	O	Khanabad	1978	3840	ms	sg?
Tadzhikistan		Madaniyat	Eoc. VII	O	Alay	1978	3880	ms	sg?
Uzbekistan?	4?	Makhram	Olig. II-III	O	Sumsar	1985?	3500	ms	sg?
Uzbekistan		Mingbulak	Mioc. kkp	O	Massaget	1983*	5245	ms	?
Uzbekistan		Mingbulak	Olig. III	O	Sumsar	1983*	5590	ms	?
Uzbekistan		Mingbulak	Paleoc. VIII	O	Bukhara	1983*	5860	mc	?
Uzbekistan		Mingbulak	Paleoc. IX	GC	Bukhara	1983*	5899	ms	?
Tadzhikistan		Niyazbek-Karakchikum	Olig. II (III)	O	Sumsar	1974	3750	ms	sg
Tadzhikistan		Niyazbek-Karakchikum	Eoc. IV	O	Khanabad	1974	3790	ms	sg
Tadzhikistan		Niyazbek-Karakchikum	Eoc. V	O	Turkestan	1974	3800	mc	sg
Tadzhikistan		Niyazbek-Karakchikum	Eoc. VI	GC	Turkestan	1974	3810	mc	gd
Tadzhikistan		Niyazbek-Karakchikum	Eoc. VIIa	GC	Alay	1974	3830	ms	gd
Tadzhikistan		Niyazbek-Karakchikum	Paleoc. IX	GC	Bukhara	1974	3850	ms	gd
Tadzhikistan		Niyazbek-Karakchikum	U. Cret. XI-XII	GC	Pestrotsvet	1974	3900	ms	gd
Tadzhikistan		Ravat	Olig. II (III)	O	Sumsar	1961	3150	ms	wd
Tadzhikistan		Ravat	Eoc. IV	O	Khanabad	1961	3275	tc	wd
Tadzhikistan		Ravat	Eoc. V	GC	Turkestan	1961	3290	mc	wd
Tadzhikistan		Ravat	Eoc. VII	O	Alay	1961	3450	mc	wd
Tadzhikistan		Ravat	Paleoc. IX-IXa	GC	Bukhara	1961	3550	ms	wd
Uzbekistan	4	Varyk	Olig. II (III)	O	Sumsar	1971	3200	ms	sg?
Uzbekistan	4	Varyk	Eoc. IV	O	Khanabad	1971	3500	ms	sg?
Uzbekistan	4	Varyk	Eoc. V	G	Turkestan	1971	3550	mc	gd?

Table E1. Basic Information and Estimates, by Reservoir for Fields Discovered through 1987, Fergana Basin (Metric Units) Continued

Republic	Uz Blk	Field Name	Pay Zone Identification	Petro-leum Type	Formation Name	Field Dis-covery Year	Depth (m)	Lith-ology Type	Drive Type
Uzbekistan	4	Varyk	Eoc. VII	O	Alay	1971	3708	mc	sg?
Uzbekistan	4	Varyk	Paleoc. IX	O	Bukhara	1971	3800	ms	sg?
Uzbekistan	4	Varyk II	Olig. II (III)	O	Sumsar	1978	4500	ps	sg?
Uzbekistan	4	Varyk II	Eoc. IV	O	Khanabad	1978	5060	ts	sg?
Uzbekistan	4	Varyk II	Eoc. VII	O	Alay	1978	5100	tc	sg?
Total 3 republics		53 fields and field-combinations	177 reservoirs	121 O-GO-OG 56 G-GC reservoirs					

Notes: At least 7 additional fields exist (1993 Uzbek & Petroconsultants information), which were prob. discovered after 1987.

Available data do not provide accurate field locations. However, fields were assigned to republic areas, and further, to Uzbek license blocks offered on 08-25-93 (Uz Blk). 3p and 4p indicate field combinations that cross republic borders, with parts in Uzbek blocks 3 and 4.

Volumetric calculations used piecemeal data sources and estimates. Some of the most sensitive data to calculations (reservoir area and thickness), were the least reliable.

Listing of fields in the central basin graben is from Glumakov, et al, 1988; not all are deep-basin.

Initial field discovery year used for all reservoirs in that field.

For Mingbulak field, data listed with 1983* (asterisk) discovery year relate to estimates following the 1992 oil blowout.

Totals may not equal sum of components due to independent rounding. Other calculations also use complete values rather than the rounded values shown.

N-E-S-W as directions of north, east, south, and west.

? = particularly questionable.

Pay Zones as Plioc., Mioc., Olig., Eoc., Paleoc. are epochs of Tertiary Period (Pliocene, Miocene, Oligocene, Eocene, Paleocene). U. and L. Cret. are Upper and Lower Cretaceous Epochs. Jura. is Jurassic Period and Permo-Trias. is a composite zone of the Permian-Triassic Periods.

Petroleum Type as that in the reservoir; O = oil, G = natural gas, GC = gas condensate; when GO or OG is listed, the last letter indicates dominance.

Units as m = meters.

Lithology Type as ts-ms-ps indicate sandstones in categories of tight-medium-more permeable, with separations at 10 and 600 millidarcies; tc-mc-pc indicate carbonates with the same permeability categories.

Drive Type as reservoir fluid energy, with wd = water drive; sg = solution gas drive; gc = gas cap drive; gd = gas depletion drive; wf = water-flood for improved recovery.

Source: Energy Information Administration, Office of Oil and Gas.

Table E2. Fluid Volumetric Estimates, by Reservoir for Fields Discovered through 1987, Fergana Basin (Metric Units)

Field Name	Pay Zone Identification	Petro-leum Type	Original Oil In Place (MMstcm)	Total Ultimate Recoverable Oil, Primary + Waterflood (MMstcm)	Total Ultimate Recoverable A-D Gas, Pri. + Wf. (MMscm)	Original NA Gas In Place (MMscm)	Ultimate Recoverable NA Gas (MMscm)
North Basin Flank							
Bedresay	L. Cret. XVIIIg	G	--	--	--	1207.076	881.165
Izbaskent	Olig. II (III)	O	1.218	0.207	12.546	--	--
Izbaskent	Eoc. V-VII	O	1.902	0.152	10.670	--	--
Izbaskent	Paleoc. IX	O	1.560	0.281	18.778	--	--
Izbaskent	Paleoc. X	O	1.554	0.295	20.254	--	--
Izbaskent	U. Cret. XII	G	--	--	--	658.595	507.118
Izbaskent	U. Cret. XIII	G	--	--	--	2355.697	1766.773
Izbaskent	U. Cret. XIV	G	--	--	--	626.186	457.116
Izbaskent	U. Cret. XV	G	--	--	--	845.132	608.495
Izbaskent	L. Cret. XVIII	G	--	--	--	1012.964	719.205
Kassansay	Olig. II (III)	O	2.364	1.300	128.604	--	--
Kyzyl-Alma	Jura. XXIII	G	--	--	--	1555.324	1150.940
Maylisay	Eoc. V	O	0.966	0.309	10.192	--	--
Maylisu III	Olig. II (III)	O	2.101	0.525	49.692	--	--
Maylisu III	Eoc. V	O	1.231	0.308	34.200	--	--
Maylisu III	Eoc. VII	O	1.915	0.192	21.289	--	--
Maylisu III	U. Cret. XIII	G	--	--	--	1213.502	1019.342
Maylisu III	U. Cret. XVII	G	--	--	--	823.860	692.043
Maylisu III	L. Cret. XVIIIa	G	--	--	--	867.772	728.928
Maylisu III	Jura. XXIII	G	--	--	--	2037.769	1650.593
Maylisu IV-Izbaskent, Vost. (E)	Mioc. kkr	O	18.664	4.106	143.027	--	--
Maylisu IV-Izbaskent, Vost. (E)	Olig. II (III)	O	21.166	1.905	68.841	--	--
Maylisu IV-Izbaskent, Vost. (E)	Eoc. V	O	7.304	0.730	31.510	--	--
Maylisu IV-Izbaskent, Vost. (E)	Eoc. VIIa	O	6.010	0.601	28.778	--	--
Maylisu IV-Izbaskent, Vost. (E)	Paleoc. IX	O	0.819	0.139	7.229	--	--
Maylisu IV-Izbaskent, Vost. (E)	U. Cret. XIII	GO	6.144	2.949	275.021	--	--
Maylisu IV-Izbaskent, Vost. (E)	U. Cret. XIV	GO	1.670	0.518	48.282	--	--
Maylisu IV-Izbaskent, Vost. (E)	U. Cret. XV	G	--	--	--	433.055	350.774
Maylisu IV-Izbaskent, Vost. (E)	U. Cret. XVI	G	--	--	--	504.664	403.731
Maylisu IV-Izbaskent, Vost. (E)	U. Cret. XVII	G	--	--	--	537.937	430.350
Maylisu IV-Izbaskent, Vost. (E)	L. Cret. XVIII	GC	--	--	--	1055.587	844.470
Maylisu IV-Izbaskent, Vost. (E)	L. Cret. XIX	G	--	--	--	525.281	430.731
Maylisu IV-Izbaskent, Vost. (E)	L. Cret. XXII	G	--	--	--	429.912	343.930
Maylisu IV-Izbaskent, Vost. (E)	Jura. XXIII	G	--	--	--	1860.423	1469.734
Namangan	Eoc. V	O	2.271	0.295	44.155	--	--
Shorbulak	Eoc. V	O	1.308	0.562	83.147	--	--
Tergachi	Mioc. kkr	O	9.779	5.672	575.009	--	--
Tergachi	Eoc. V	O	1.448	0.594	70.206	--	--
South Flank - NE of Fergana							
Alamyshik, Sever. (N)	Olig. II (III)	O	7.898	1.659	137.648	--	--
Alamyshik, Yuzh. (S)	Plioc. I+Ia	O	8.156	0.979	48.735	--	--
Alamyshik, Yuzh. (S)	Plioc. Ib	O	7.442	2.233	92.643	--	--
Alamyshik, Yuzh. (S)	Mioc. Ic	O	4.175	1.252	48.849	--	--
Alamyshik, Yuzh. (S)	Olig. II (III)	O	4.191	1.257	31.306	--	--
Alamyshik, Yuzh. (S)	Eoc. V-VII	O	2.831	0.368	8.551	--	--
Alamyshik, Yuzh. (S)	L. Cret. XVIII	O	3.550	0.781	25.478	--	--
Alamyshik, Yuzh. (S)	L. Cret. XIX-XXII	O	0.735	0.169	6.854	--	--
Alamyshik, Yuzh. (S)	Jura. XXIII	GO	0.379	0.087	4.918	--	--
Andizhan	Plioc. I	GO	2.205	0.353	15.268	--	--
Andizhan	Olig. III	GO	2.448	0.612	54.935	--	--
Andizhan	Eoc. V	GO	0.619	0.050	6.104	--	--
Andizhan	Eoc. VI	GO	0.551	0.044	5.620	--	--
Andizhan	Eoc. VII	GO	1.004	0.080	11.907	--	--
Andizhan	Paleoc. VIII	G	--	--	--	169.716	125.590
Boston	Plioc. I	O	4.274	1.069	10.014	--	--

Table E2. Fluid Volumetric Estimates, by Reservoir for Fields Discovered through 1987, Fergana Basin (Metric Units) Continued

Field Name	Pay Zone Identification	Petro-leum Type	Original Oil In Place (MMstcm)	Total Ultimate Recoverable Oil, Primary + Waterflood (MMstcm)	Total Ultimate Recoverable A-D Gas, Pri. + Wf. (MMscm)	Original NA Gas In Place (MMscm)	Ultimate Recoverable NA Gas (MMscm)
Boston	Mioc. Ia	O	3.690	0.923	31.436	--	--
Boston	Mioc. I	O	4.664	1.259	74.016	--	--
Boston	Olig. II (III)	O	3.100	0.837	28.554	--	--
Boston	Olig. III	O	1.995	0.539	27.565	--	--
Boston	L. Cret. XIX	G	--	--	--	332.299	259.194
Boston	L. Cret. XX+XXI+XXII	GO	0.977	0.205	20.139	--	--
Boston	Jura. XXVII	G	--	--	--	220.596	173.715
Boston	Permo-Trias. XXX	O	0.157	0.022	2.830	--	--
Changyrtash	Olig. III	O	7.369	1.842	107.616	--	--
Changyrtash	Eoc. V	O	2.709	0.271	13.367	--	--
Chigirchik	Jura. XXIII	O	9.126	4.381	56.524	--	--
Khartum	Olig. III	O	1.685	0.354	30.664	--	--
Khartum	Eoc. VI	O	1.190	0.274	33.823	--	--
Khartum	Eoc. VII	G	--	--	--	208.464	154.263
Khartum	L. Cret. XXII	GO	1.924	0.269	43.427	--	--
Khartum, Vost. (E)	Olig. II-III	O	3.354	1.308	118.721	--	--
Khartum. Vost. (E)	Eoc. VI	G	--	--	--	1175.508	952.162
Khodzhaosman	L. Cret. XVIII	O	0.654	0.131	6.260	--	--
Palvantash	Plioc. I + Olig. III	O	0.726	0.247	1.074	--	--
Palvantash	Eoc. IV-VI	GO	5.513	1.654	9.899	--	--
Palvantash	Eoc. VII-VIII	GO	4.268	1.280	16.422	--	--
Palvantash	U. Cret. XIII+XIV	G	--	--	--	471.350	400.647
Palvantash	L. Cret. XVIIIg	G	--	--	--	27.145	21.445
Palvantash, Zap. (W)	Mioc. bgr	O	7.534	3.843	92.479	--	--
Palvantash, Zap. (W)	Olig. IIIb	O	3.280	1.542	16.211	--	--
Palvantash, Zap. (W)	Eoc. V+VI	O	1.087	0.565	38.615	--	--
Palvantash, Zap. (W)	Eoc. VII	O	0.876	0.307	13.433	--	--
Palvantash, Zap. (W)	Eoc. VIII-IX	O	0.759	0.319	22.340	--	--
Sharikhan-Khodzhiabad	Olig. II-III	O	6.333	1.583	67.686	--	--
Sharikhan-Khodzhiabad	Eoc. V	O	1.554	0.140	5.825	--	--
Sharikhan-Khodzhiabad	Eoc. VI	G	--	--	--	201.509	159.192
Sharikhan-Khodzhiabad	Eoc. VII	O	18.285	1.646	68.551	--	--
Sharikhan-Khodzhiabad	Eoc. VIII	GO	7.984	3.353	286.715	--	--
Sharikhan-Khodzhiabad	L. Cret. XIX-XXII	GO	18.796	10.526	1049.813	--	--
Sharikhan-Khodzhiabad	Jura. XXIII-XXIX	GO	5.384	2.530	266.753	--	--
Suzak	L. Cret. XIX	G	--	--	--	2583.050	2014.779
Suzak	L. Cret. XXI	G	--	--	--	3479.565	2853.243
South Flank - SW of Fergana							
Aksaray	Eoc. VII	G	--	--	--	180.202	140.558
Aksaray	Paleoc. VIII	G	--	--	--	141.160	107.282
Avval'	Eoc. V	O	2.111	1.034	41.066	--	--
Avval', Vost. (E)	Eoc. V	O	0.873	0.349	11.871	--	--
Ayritan	Olig. II (III)	GO	0.741	0.044	1.657	--	--
Ayritan	Eoc. V	O	1.163	0.070	2.838	--	--
Ayritan	Eoc. VII	O	3.939	0.473	21.900	--	--
Ayritan	Paleoc. IX	G	--	--	--	473.379	369.235
Beshkent-Togap	Olig. II (III)	O	4.966	1.241	21.620	--	--
Chaur-Yarkutan-Chimion	Eoc. IV	O	4.791	1.054	13.712	--	--
Chaur-Yarkutan-Chimion	Eoc. V, VI	O	7.254	1.741	27.289	--	--
Chongara-Gal'cha	Eoc. IV	GO	24.456	5.380	990.904	--	--
Chongara-Gal'cha	Eoc. V	G	--	--	--	503.227	392.517
Chongara-Gal'cha	Eoc. VII	G	--	--	--	1411.594	1072.812
Karagachi-Tamchi	Eoc. IV	O	29.351	8.512	951.855	--	--
Khankyz	Olig. II (III)	O	1.791	0.573	5.053	--	--
Khankyz	Eoc. VII	O	5.753	2.186	19.052	--	--
Khankyz	L. Cret. XVIII	G	--	--	--	1523.823	1158.105
Kim (Sel'rokho)	Olig. II (III)	O	10.417	2.604	89.065	--	--

Table E2. Fluid Volumetric Estimates, by Reservoir for Fields Discovered through 1987, Fergana Basin (Metric Units) Continued

Field Name	Pay Zone Identification	Petro-leum Type	Original Oil In Place (MMstcm)	Total Ultimate Recoverable Oil, Primary + Waterflood (MMstcm)	Total Ultimate Recoverable A-D Gas, Pri. + Wf. (MMscm)	Original NA Gas In Place (MMscm)	Ultimate Recoverable NA Gas (MMscm)
Kim (Sel'rokho)	Eoc. V	O	7.780	0.934	39.436	--	--
Kim (Sel'rokho)	Eoc. VI	O	15.922	4.299	188.853	--	--
Kim (Sel'rokho)	Eoc. VIa	O	8.797	2.375	104.337	--	--
Kim (Sel'rokho)	Eoc. VII	O	18.147	2.178	91.983	--	--
Nefteabad	Olig. II (III)	GO	5.622	0.562	20.543	--	--
Obi-Shifo	Olig. II-III	O	2.661	0.665	22.753	--	--
Rishtan, Sever. (N)	U. Cret. XIV	G	--	--	--	194.685	155.748
Rishtan, Sever. (N)	U. Cret. XVI + XVII	O	2.105	0.568	28.978	--	--
Rishtan, Sever. (N)	L. Cret. XVIIIg	G	--	--	--	220.624	176.500
Rishtan, Sever. (N)	Jura. XXIII-XXIX	G	--	--	--	1457.762	1166.209
Sarykamysh	U. Cret. XIV	G	--	--	--	83.571	68.529
Sarykamysh	L. Cret. XVII	G	--	--	--	147.792	116.756
Sarykamysh	Jura. XXIII	G	--	--	--	665.985	546.108
Sarytok	Jura. XXVI	G	--	--	--	129.978	103.982
Shorsu IV	Olig. II (III)	O	1.764	0.441	11.378	--	--
Shorsu IV	Eoc. IV	O	0.951	0.238	8.128	--	--
Shorsu IV	Eoc. V	OG	0.685	0.055	2.094	--	--
Shorsu IV	Eoc. VI	O	0.946	0.255	9.112	--	--
Shorsu IV	Eoc. VII	O	3.224	0.322	11.092	--	--
Shorsu IV	Paleoc. VIII	O	0.889	0.089	3.464	--	--
Shorsu IV	Paleoc. IX	O	0.764	0.183	7.988	--	--
Shorsu VI	Eoc. VII	G	--	--	--	329.998	254.098
Sokh, Sever. (N)	Olig. II	OG	10.922	2.075	75.828	--	--
Sokh, Sever. (N)	Eoc. IV	GO	2.029	0.264	8.967	--	--
Sokh, Sever. (N)	Eoc. V	GC	--	--	--	774.234	619.387
Sokh, Sever. (N)	Eoc. VII	G	--	--	--	1078.279	862.623
Sokh, Sever. (N)	Paleoc. VIII	O	6.819	0.886	37.444	--	--
Sokh, Sever. (N)	U. Cret. XIV-XV	GO	7.652	0.842	70.687	--	--
Sokh, Sever. (N)	L. Cret. XVIIIg	GC	--	--	--	1375.257	1058.948
Sokh, Sever. (N)	L. Cret. XXII	GC	--	--	--	232.995	184.066
Sokh, Sever. (N)	Jura. XXIV-XXV	GC	--	--	--	1371.127	1083.190
Tasravet	Eoc. IV	O	1.687	0.455	22.951	--	--
Central Basin Graben							
Achisu	Olig. II (III)	O	2.744	0.549	41.724	--	--
Gumkhana	Plioc. I	O	5.978	0.956	170.343	--	--
Gumkhana	Mioc.(?)	O	14.751	2.213	433.491	--	--
Kanibadam	Eoc. V	O	0.921	0.074	5.613	--	--
Kanibadam	Eoc. VII	O	2.673	0.241	18.526	--	--
Kanibadam	Paleoc. IX+IXa	GC	--	--	--	1523.955	1097.247
Kanibadam, Sever. (N)	Olig. II (III)	O	2.041	0.429	38.409	--	--
Madaniyat	Olig. II	O	2.574	0.515	39.851	--	--
Madaniyat	Eoc. IV	O	2.615	0.497	40.604	--	--
Madaniyat	Eoc. VII	O	7.815	1.532	118.613	--	--
Makhram	Olig. II-III	O	1.519	0.304	25.663	--	--
Mingbulak	Mioc. kkp	O	110.328	17.652	4124.984	--	--
Mingbulak	Oilig. III	O	31.761	5.082	1419.324	--	--
Mingbulak	Paleoc. VIII	O	21.736	3.478	971.340	--	--
Mingbulak	Paleoc. IX	GC	--	--	--	14752.732	9736.803
Niyazbek-Karakchikum	Olig. II (III)	O	7.595	1.519	143.724	--	--
Niyazbek-Karakchikum	Eoc. IV	O	5.395	1.079	111.382	--	--
Niyazbek-Karakchikum	Eoc. V	O	3.513	0.351	36.260	--	--
Niyazbek-Karakchikum	Eoc. VI	GC	--	--	--	1509.236	1071.557
Niyazbek-Karakchikum	Eoc. VIIa	GC	--	--	--	4380.874	3022.803
Niyazbek-Karakchikum	Paleoc. IX	GC	--	--	--	2341.457	1615.605
Niyazbek-Karakchikum	U. Cret. XI-XII	GC	--	--	--	1813.033	1250.993
Ravat	Olig. II (III)	O	2.904	1.713	497.451	--	--
Ravat	Eoc. IV	O	3.640	1.201	37.062	--	--

Table E2. Fluid Volumetric Estimates, by Reservoir for Fields Discovered through 1987, Fergana Basin (Metric Units) Continued

Field Name	Pay Zone Identification	Petro-leum Type	Original Oil In Place (MMstcm)	Total Ultimate Recoverable Oil, Primary + Waterflood (MMstcm)	Total Ultimate Recoverable A-D Gas, Pri. + Wf. (MMscm)	Original NA Gas In Place (MMscm)	Ultimate Recoverable NA Gas (MMscm)
Ravat	Eoc. V	GC	--	--	--	341.435	242.419
Ravat	Eoc. VII	O	1.652	0.710	88.556	--	--
Ravat	Paleoc. IX-IXa	GC	--	--	--	822.742	592.374
Varyk	Olig. II (III)	O	4.490	0.943	85.576	--	--
Varyk	Eoc. IV	O	2.394	0.455	57.441	--	--
Varyk	Eoc. V	G	--	0.000	0.000	841.224	580.444
Varyk	Eoc. VII	O	6.398	0.576	69.551	--	--
Varyk	Paleoc. IX	O	6.024	1.145	139.409	--	--
Varyk II	Olig. II (III)	O	1.751	0.403	47.893	--	--
Varyk II	Eoc. IV	O	1.272	0.178	22.566	--	--
Varyk II	Eoc. VII	O	3.158	0.284	36.017	--	--
Total 53 fields and field-combinations	177 reservoirs	121 O-GO-OG 56 G-GC reservoirs	721.436 MMstcm OOIP	161.808 MMstcm Rec. Oil	16526.289 MMscm Rec. A-D Gas	68042.300 MMscm OGIP (NA)	50416.567 MMscm Rec. NA Gas

Notes: At least 7 additional fields exist (1993 Uzbek & Petroconsultants information), which were probably discovered after 1987.

Volumetric calculations used piecemeal data sources and estimates. Some of the most sensitive data to calculations (reservoir area and thickness), were the least reliable.

Listing of fields in the central basin graben is from Glumakov, et al, 1988; not all are deep-basin.

Initial field discovery year used for all reservoirs in that field.

For Mingbulak field, data listed with 1983* (asterisk) discovery year relate to estimates following the 1992 oil blowout.

Totals may not equal sum of components due to independent rounding. Other calculations also use complete values rather than the rounded values shown.

N-E-S-W as directions of north, east, south, and west.

Pay Zones as Plioc., Mioc., Olig., Eoc., Paleoc. are epochs of Tertiary Period (Pliocene, Miocene, Oligocene, Eocene, Paleocene). U. an L. Cret. are Upper and Lower Cretaceous Epochs. Jura. is Jurassic Period and Permo-Trias. is a composite zone of the Permian-Triassic Periods.

Petroleum Type as that in the reservoir; O = oil, G = natural gas, GC = gas condensate; when GO or OG is listed, the last letter indicates dominance.

Units as MMstcm = million stock tank cubic meters oil; MMscm = million standard cubic meters gas. These units represent surface conditions.

Primary (Pri.) = oil recovery mechanism, including liquid expansion; Waterflood (Wf.) = improved oil recovery by waterflood; A-D Gas = associated-and/or-dissolved gas in oil reservoirs or produced with the oil. NA Gas = nonassociated (free) gas; OOIP = original oil in place; OGIP = original NA gas in place.

Source: Energy Information Administration, Office of Oil and Gas.

Table E3. Reservoir Parameter Estimates, by Reservoir for Fields Discovered through 1987, Fergana Basin (Metric Units)

Field Name	Pay Zone Identification	Petroleum Type	Reservoir Area (sq km)	Net Pay Thickness (m)	Porosity (frac)	Water Saturation (frac)	Initial Reservoir Pressure (MPa)	Gas Reservoir Abandon. Pressure (MPa)	Initial Reservoir Temperature (deg C)	Reported Permeability (E-15 sq m)
North Basin Flank										
Bedresay	L. Cret. XVIIIr	G	4.875	12.0	0.100	0.25	33.23	6.79	80	
Izbaskent	Olig. II (III)	O	5.985	2.0	0.180	0.34	30.57	--	45	300.00
Izbaskent	Eoc. V-VII	O	9.310	2.0	0.180	0.32	29.32	--	57	600.00
Izbaskent	Paleoc. IX	O	9.310	2.0	0.150	0.33	30.00	--	69	335.00
Izbaskent	Paleoc. X	O	9.310	2.0	0.150	0.33	30.30	--	69	
Izbaskent	U. Cret. XII	G	3.920	6.0	0.160	0.35	30.30	5.66	71	
Izbaskent	U. Cret. XIII	G	3.920	15.0	0.250	0.36	28.10	5.74	72	1024.00
Izbaskent	U. Cret. XIV	G	3.920	6.0	0.150	0.33	31.10	6.65	79	
Izbaskent	U. Cret. XV	G	3.920	8.0	0.150	0.33	32.10	6.90	81	
Izbaskent	L. Cret. XVIII	G	2.100	24.0	0.100	0.25	32.60	7.24	84	
Kassansay	Olig. II (III)	O	4.875	6.0	0.160	0.35	19.41	--	56	
Kyzyl-Alma	Jura. XXIII	G	3.250	23.0	0.110	0.27	29.45	6.22	75	50.00
Maylisay	Eoc. V	O	3.900	3.7	0.120	0.39	4.10	--	25	3.60
Maylisu III	Olig. II (III)	O	5.850	4.5	0.160	0.35	6.49	--	37	
Maylisu III	Eoc. V	O	5.850	3.7	0.100	0.25	7.10	--	38	
Maylisu III	Eoc. VII	O	5.850	5.2	0.120	0.29	7.41	--	38	
Maylisu III	U. Cret. XIII	G	5.850	17.0	0.146	0.27	10.10	--	40	600.00
Maylisu III	U. Cret. XVII	G	5.850	7.0	0.158	0.30	16.10	2.77	48	
Maylisu III	L. Cret. XVIIIa	G	5.850	7.0	0.150	0.28	17.44	2.83	48	600.00
Maylisu III	Jura. XXIII	G	5.850	12.0	0.180	0.35	24.91	4.23	59	170.00
Maylisu IV-Izbaskent, Vost. (E)	Mioc. kkp	O	18.900	12.0	0.130	0.30	12.82	--	46	
Maylisu IV-Izbaskent, Vost. (E)	Olig. II (III)	O	57.750	4.6	0.151	0.42	13.26	--	24	7.00
Maylisu IV-Izbaskent, Vost. (E)	Eoc. V	O	54.390	2.0	0.110	0.31	13.87	--	48	
Maylisu IV-Izbaskent, Vost. (E)	Eoc. VIIa	O	45.325	2.0	0.110	0.31	14.18	--	48	
Maylisu IV-Izbaskent, Vost. (E)	Paleoc. IX	O	4.550	2.0	0.160	0.35	14.49	--	49	
Maylisu IV-Izbaskent, Vost. (E)	U. Cret. XIII	GO	4.550	17.0	0.137	0.26	15.00	--	43	603.00
Maylisu IV-Izbaskent, Vost. (E)	U. Cret. XIV	GO	4.550	6.0	0.100	0.22	16.50	--	44	540.00
Maylisu IV-Izbaskent, Vost. (E)	U. Cret. XV	G	4.550	6.0	0.102	0.23	18.00	3.62	48	425.00
Maylisu IV-Izbaskent, Vost. (E)	U. Cret. XVI	G	4.550	6.0	0.130	0.29	18.68	3.71	55	
Maylisu IV-Izbaskent, Vost. (E)	U. Cret. XVII	G	4.550	6.0	0.125	0.25	19.64	3.89	52	520.00
Maylisu IV-Izbaskent, Vost. (E)	L. Cret. XVIII	GC	7.350	7.0	0.120	0.25	22.25	4.18	57	520.00
Maylisu IV-Izbaskent, Vost. (E)	L. Cret. XIX	G	7.350	3.7	0.100	0.33	31.40	4.52	60	45.00
Maylisu IV-Izbaskent, Vost. (E)	L. Cret. XXII	G	7.350	3.7	0.072	0.24	32.60	4.98	65	20.00
Maylisu IV-Izbaskent, Vost. (E)	Jura. XXIII	G	4.550	12.0	0.200	0.37	29.70	5.16	67	170.00
Namangan	Eoc. V	O	16.363	4.0	0.061	0.20	60.81	--	90	75.00
Shorbulak	Eoc. V	O	6.500	3.8	0.100	0.25	51.00	--	96	
Tergachi	Mioc. kkp	O	9.750	16.0	0.110	0.27	51.00	--	86	
Tergachi	Eoc. V	O	9.750	3.1	0.110	0.40	52.80	--	150	1.80
South Flank - NE of Fergana										
Alamyshik, Sever. (N)	Olig. II (III)	O	8.125	10.5	0.180	0.36	38.10	--	70	
Alamyshik, Yuzh. (S)	Plioc. I+Ia	O	4.620	17.0	0.180	0.34	3.60	--	33	201.00
Alamyshik, Yuzh. (S)	Plioc. Ib	O	4.620	15.2	0.180	0.34	4.20	--	33	201.00
Alamyshik, Yuzh. (S)	Mioc. Ic	O	4.620	8.0	0.210	0.40	4.54	--	35	89.00
Alamyshik, Yuzh. (S)	Olig. II (III)	O	4.830	7.8	0.200	0.40	4.95	--	35	67.00
Alamyshik, Yuzh. (S)	Eoc. V-VII	O	3.220	12.6	0.100	0.25	4.60	--	36	67.00
Alamyshik, Yuzh. (S)	L. Cret. XVIII	O	2.100	17.0	0.170	0.34	11.92	--	63	
Alamyshik, Yuzh. (S)	L. Cret. XIX-XXII	O	0.700	12.0	0.140	0.29	14.74	--	50	
Alamyshik, Yuzh. (S)	Jura. XXIII	GO	0.700	10.0	0.100	0.36	14.80	--	54	162.00
Andizhan	Plioc. I	GO	4.200	8.4	0.090	0.22	2.50	--	31	238.00
Andizhan	Olig. III	GO	4.060	7.0	0.180	0.40	5.20	--	37	34.00
Andizhan	Eoc. V	GO	0.840	7.5	0.200	0.34	5.80	--	38	360.00
Andizhan	Eoc. VI	GO	0.840	7.5	0.180	0.34	7.09	--	43	
Andizhan	Eoc. VII	GO	0.840	14.0	0.180	0.33	8.10	--	41	350.00
Andizhan	Paleoc. VIII	G	0.840	18.0	0.180	0.33	7.00	2.15	31	35.00
Boston	Plioc. I	O	2.520	14.0	0.225	0.44	4.10	--	31	69.00

Table E3. Reservoir Parameter Estimates, by Reservoir for Fields Discovered through 1987, Fergana Basin (Metric Units) Continued

Field Name	Pay Zone Identification	Petro-leum Type	Reser-voir Area (sq km)	Net Pay Thick-ness (m)	Porosity (frac)	Water Satura-tion (frac)	Initial Reser-voir Pressure (MPa)	Gas Reser-voir Abandon. Pressure (MPa)	Initial Reser-voir Temper-ature (deg C)	Reported Perme-ability (E-15 sq m)
Boston	Mioc. Ia	O	3.920	10.4	0.150	0.34	2.50	--	24	40.00
Boston	Mioc. I	O	3.920	14.0	0.150	0.34	3.35	--	34	40.00
Boston	Olig. II (III)	O	3.920	8.2	0.160	0.34	5.20	--	22	80.00
Boston	Olig. III	O	2.520	8.5	0.160	0.33	5.50	--	36	90.00
Boston	L. Cret. XIX	G	0.840	16.0	0.150	0.34	26.79	4.52	67	40.00
Boston	L. Cret. XX+XXI+XXII	GO	0.840	20.8	0.100	0.27	21.40	--	64	22.00
Boston	Jura. XXVII	G	0.840	10.0	0.130	0.29	32.70	5.43	69	90.00
Boston	Permo-Trias. XXX	O	0.840	4.0	0.100	0.35	29.26	--	75	
Changyrtash	Olig. III	O	9.000	8.0	0.200	0.39	6.20	--	65	
Changyrtash	Eoc. V	O	6.000	5.0	0.150	0.31	6.20	--	35	
Chigirchik	Jura. XXIII	O	9.750	12.0	0.110	0.25	10.00	--	43	
Khartum	Olig. III	O	2.450	7.5	0.180	0.36	25.60	--	65	
Khartum	Eoc. VI	O	2.450	7.5	0.145	0.39	26.60	--	71	9.00
Khartum	Eoc. VII	G	1.225	6.6	0.145	0.29	25.88	5.77	72	
Khartum	L. Cret. XXII	GO	2.450	12.0	0.140	0.29	31.20	--	100	
Khartum, Vost. (E)	Olig. II-III	O	3.413	12.0	0.160	0.35	31.40	--	60	45.00
Khartum. Vost. (E)	Eoc. VI	G	3.413	10.0	0.245	0.53	34.85	5.02	68	23.00
Khodzhaosman	L. Cret. XVIII	O	1.540	4.0	0.200	0.39	6.10	--	35	
Palvantash	Plioc. I + Olig. III	O	0.840	14.0	0.100	0.37	4.10	--	31	2.20
Palvantash	Eoc. IV-VI	GO	3.500	13.0	0.240	0.48	5.80	--	36	40.00
Palvantash	Eoc. VII-VIII	GO	1.260	27.0	0.200	0.34	8.10	--	40	500.00
Palvantash	U. Cret. XIII+XIV	G	3.500	10.0	0.125	0.27	12.50	2.08	42	
Palvantash	L. Cret. XVIIIr	G	0.420	3.0	0.150	0.31	19.51	4.07	58	
Palvantash, Zap. (W)	Mioc. brp	O	2.520	30.0	0.180	0.40	13.15	--	51	34.00
Palvantash, Zap. (W)	Olig. IIIb	O	3.640	10.0	0.139	0.31	18.70	--	63	70.00
Palvantash, Zap. (W)	Eoc. V+VI	O	2.772	6.6	0.095	0.25	21.60	--	77	73.00
Palvantash, Zap. (W)	Eoc. VII	O	1.260	6.6	0.180	0.33	21.10	--	81	405.00
Palvantash, Zap. (W)	Eoc. VIII-IX	O	2.520	3.0	0.180	0.33	24.05	--	85	
Sharikhan-Khodzhiabad	Olig. II-III	O	8.330	8.0	0.160	0.33	5.10	--	34	80.00
Sharikhan-Khodzhiabad	Eoc. V	O	7.840	2.0	0.160	0.30	6.70	--	37	322.00
Sharikhan-Khodzhiabad	Eoc. VI	G	7.840	3.0	0.160	0.30	6.70	1.56	38	322.00
Sharikhan-Khodzhiabad	Eoc. VII	O	8.330	19.0	0.200	0.35	7.10	--	35	346.00
Sharikhan-Khodzhiabad	Eoc. VIII	GO	11.900	8.0	0.170	0.37	11.30	--	72	39.00
Sharikhan-Khodzhiabad	L. Cret. XIX-XXII	GO	7.840	32.0	0.148	0.33	20.60	--	73	58.00
Sharikhan-Khodzhiabad	Jura. XXIII-XXIX	GO	7.840	12.0	0.110	0.31	26.19	--	69	10.00
Suzak	L. Cret. XIX	G	7.800	16.0	0.147	0.32	19.90	4.21	59	
Suzak	L. Cret. XXI	G	7.800	16.0	0.155	0.33	28.00	4.30	60	
South Flank - SW of Fergana										
Aksaray	Eoc. VII	G	2.503	8.7	0.170	0.40	7.36	1.73	39	
Aksaray	Paleoc. VIII	G	2.503	6.0	0.140	0.33	9.01	2.32	44	
Avval'	Eoc. V	O	5.850	3.4	0.340	0.65	7.80	--	38	11.10
Avval', Vost. (E)	Eoc. V	O	3.120	3.0	0.225	0.54	9.80	--	45	12.20
Ayritan	Olig. II (III)	GO	4.648	3.0	0.170	0.65	12.80	--	48	0.05
Ayritan	Eoc. V	O	4.648	3.0	0.180	0.47	13.40	--	71	8.70
Ayritan	Eoc. VII	O	4.648	8.7	0.200	0.45	15.20	--	30	23.00
Ayritan	Paleoc. IX	G	4.648	5.5	0.160	0.34	15.70	3.56	54	73.30
Beshkent-Togap	Olig. II (III)	O	11.700	4.5	0.180	0.44	20.00	--	54	
Chaur-Yarkutan-Chimion	Eoc. IV	O	10.498	4.2	0.190	0.40	2.84	--	30	
Chaur-Yarkutan-Chimion	Eoc. V, VI	O	10.498	6.3	0.210	0.45	4.60	--	31	28.00
Chongara-Gal'cha	Eoc. IV	GO	33.250	10.0	0.160	0.31	5.50	--	34	150.00
Chongara-Gal'cha	Eoc. V	G	23.800	5.0	0.140	0.30	4.20	0.95	33	100.00
Chongara-Gal'cha	Eoc. VII	G	23.800	11.0	0.210	0.41	4.20	1.04	33	60.00
Karagachi-Tamchi	Eoc. IV	O	42.900	6.3	0.220	0.35	31.65	--	70	781.00
Khankyz	Olig. II (III)	O	2.250	9.0	0.170	0.45	15.20	--	43	7.00
Khankyz	Eoc. VII	O	4.500	12.0	0.194	0.42	17.20	--	56	12.00
Khankyz	L. Cret. XVIII	G	2.250	25.0	0.180	0.39	27.50	5.60	80	35.00
Kim (Sel'rokho)	Olig. II (III)	O	27.300	3.0	0.220	0.36	1.80	--	36	275.00

Table E3. Reservoir Parameter Estimates, by Reservoir for Fields Discovered through 1987, Fergana Basin (Metric Units) Continued

Field Name	Pay Zone Identification	Petroleum Type	Reservoir Area (sq km)	Net Pay Thickness (m)	Porosity (frac)	Water Saturation (frac)	Initial Reservoir Pressure (MPa)	Gas Reservoir Abandon. Pressure (MPa)	Initial Reservoir Temperature (deg C)	Reported Permeability (E-15 sq m)
Kim (Sel'rokho)	Eoc. V	O	27.300	3.3	0.150	0.35	2.30	--	36	
Kim (Sel'rokho)	Eoc. VI	O	27.300	5.6	0.200	0.41	6.16	--	37	
Kim (Sel'rokho)	Eoc. VIa	O	27.300	3.0	0.210	0.42	6.25	--	37	
Kim (Sel'rokho)	Eoc. VII	O	27.300	7.7	0.150	0.35	6.44	--	37	
Nefteabad	Olig. II (III)	GO	17.550	4.2	0.150	0.43	5.70	--	44	5.70
Obi-Shifo	Olig. II-III	O	4.875	6.0	0.180	0.44	6.14	--	38	
Rishtan, Sever. (N)	U. Cret. XIV	G	6.500	5.0	0.128	0.28	6.10	1.30	36	187.00
Rishtan, Sever. (N)	U. Cret. XVI + XVII	O	6.500	5.0	0.100	0.25	8.60	--	39	73.00
Rishtan, Sever. (N)	L. Cret. XVIIIr	G	6.500	4.0	0.100	0.23	10.10	2.15	46	190.00
Rishtan, Sever. (N)	Jura. XXIII-XXIX	G	6.500	12.0	0.250	0.50	13.38	2.83	48	
Sarykamysh	U. Cret. XIV	G	3.380	6.0	0.160	0.33	3.80	0.71	35	79.00
Sarykamysh	L. Cret. XVIIr	G	3.380	8.0	0.101	0.23	6.48	1.47	34	
Sarykamysh	Jura. XXIII	G	3.380	12.0	0.250	0.50	11.60	2.26	43	
Sarytok	Jura. XXVI	G	0.780	10.0	0.224	0.44	11.90	2.60	46	65.51
Shorsu IV	Olig. II (III)	O	2.860	6.0	0.222	0.50	1.90	--	30	
Shorsu IV	Eoc. IV	O	2.860	3.0	0.222	0.45	2.30	--	31	
Shorsu IV	Eoc. V	OG	2.860	3.0	0.222	0.60	2.50	--	31	
Shorsu IV	Eoc. VI	O	2.860	3.0	0.222	0.45	3.50	--	32	
Shorsu IV	Eoc. VII	O	2.860	12.2	0.170	0.40	3.50	--	33	
Shorsu IV	Paleoc. VIII	O	2.860	3.7	0.140	0.33	3.50	--	33	
Shorsu IV	Paleoc. IX	O	2.860	3.0	0.150	0.33	3.50	--	34	
Shorsu VI	Eoc. VII	G	8.450	12.2	0.170	0.40	3.08	0.72	31	
Sokh, Sever. (N)	Olig. II	OG	7.280	14.0	0.240	0.50	13.70	--	45	20.00
Sokh, Sever. (N)	Eoc. IV	GO	7.280	3.0	0.170	0.39	13.00	--	49	28.00
Sokh, Sever. (N)	Eoc. V	GC	7.735	5.0	0.200	0.39	14.90	3.05	51	95.00
Sokh, Sever. (N)	Eoc. VII	G	4.550	15.3	0.125	0.28	15.10	3.17	53	94.00
Sokh, Sever. (N)	Paleoc. VIII	O	4.550	16.0	0.180	0.41	15.60	--	56	24.00
Sokh, Sever. (N)	U. Cret. XIV-XV	GO	3.360	28.0	0.210	0.51	16.80	--	59	10.00
Sokh, Sever. (N)	L. Cret. XVIIIr	GC	2.695	17.0	0.275	0.43	18.20	4.07	44	283.00
Sokh, Sever. (N)	L. Cret. XXII	GC	2.695	6.0	0.100	0.33	21.60	4.30	51	
Sokh, Sever. (N)	Jura. XXIV-XXV	GC	1.400	35.0	0.300	0.65	24.25	4.75	63	15.00
Tasravet	Eoc. IV	O	4.875	3.5	0.190	0.40	7.56	--	40	
Central Basin Graben										
Achisu	Olig. II (III)	O	5.200	6.0	0.170	0.36	39.10	--	89	
Gumkhana	Plioc. I	O	9.750	12.0	0.100	0.25	84.74	--	104	
Gumkhana	Mioc.(?)	O	9.750	30.5	0.100	0.25	92.62	--	112	
Kanibadam	Eoc. V	O	3.710	3.0	0.160	0.36	28.28	--	80	30.00
Kanibadam	Eoc. VII	O	3.710	9.1	0.150	0.35	30.40	--	80	
Kanibadam	Paleoc. IX+IXa	GC	2.968	17.5	0.160	0.31	34.00	7.11	93	193.00
Kanibadam, Sever. (N)	Olig. II (III)	O	7.956	3.0	0.170	0.36	28.90	--	79	
Madaniyat	Olig. II	O	9.750	3.0	0.170	0.36	50.47	--	95	
Madaniyat	Eoc. IV	O	9.750	3.0	0.180	0.38	42.85	--	96	
Madaniyat	Eoc. VII	O	9.750	9.1	0.170	0.36	51.00	--	96	
Makhram	Olig. II-III	O	4.875	3.6	0.170	0.36	42.76	--	89	
Mingbulak	Mioc. kkp	O	32.400	38.1	0.220	0.35	126.69	--	142	
Mingbulak	Olig. III	O	32.400	13.0	0.200	0.35	118.59	--	152	
Mingbulak	Paleoc. VIII	O	32.400	12.0	0.150	0.35	109.45	--	160	
Mingbulak	Paleoc. IX	GC	32.400	12.0	0.150	0.35	107.54	13.34	161	
Niyazbek-Karakchikum	Olig. II (III)	O	26.880	3.2	0.185	0.39	53.30	--	94	
Niyazbek-Karakchikum	Eoc. IV	O	21.000	3.0	0.180	0.38	42.29	--	95	
Niyazbek-Karakchikum	Eoc. V	O	14.000	3.2	0.170	0.40	46.90	--	95	
Niyazbek-Karakchikum	Eoc. VI	GC	14.000	3.2	0.180	0.43	50.47	8.62	95	
Niyazbek-Karakchikum	Eoc. VIIa	GC	14.000	9.4	0.170	0.36	43.61	8.66	95	
Niyazbek-Karakchikum	Paleoc. IX	GC	9.800	7.5	0.160	0.35	43.80	8.71	96	
Niyazbek-Karakchikum	U. Cret. XI-XII	GC	9.800	6.0	0.150	0.33	44.37	8.82	97	
Ravat	Olig. II (III)	O	4.060	12.0	0.180	0.40	31.30	--	60	28.00
Ravat	Eoc. IV	O	3.248	14.0	0.150	0.40	32.90	--	85	9.00

Table E3. Reservoir Parameter Estimates, by Reservoir for Fields Discovered through 1987, Fergana Basin (Metric Units) Continued

Field Name	Pay Zone Identification	Petro-leum Type	Reser-voir Area (sq km)	Net Pay Thick-ness (m)	Porosity (frac)	Water Satura-tion (frac)	Initial Reser-voir Pressure (MPa)	Gas Reser-voir Abandon. Pressure (MPa)	Initial Reser-voir Temper-ature (deg C)	Reported Perme-ability (E-15 sq m)
Ravat	Eoc. V	GC	4.060	3.0	0.170	0.40	33.70	7.44	85	42.00
Ravat	Eoc. VII	O	4.060	6.0	0.150	0.38	35.90	--	70	14.00
Ravat	Paleoc. IX-IXa	GC	3.248	10.0	0.100	0.25	46.40	8.03	72	
Varyk	Olig. II (III)	O	9.750	5.4	0.170	0.36	37.10	--	84	
Varyk	Eoc. IV	O	9.750	3.0	0.180	0.38	37.10	--	89	
Varyk	Eoc. V	G	9.750	3.4	0.118	0.28	39.40	8.03	90	
Varyk	Eoc. VII	O	9.750	9.1	0.150	0.35	37.10	--	93	
Varyk	Paleoc. IX	O	9.750	7.5	0.180	0.38	38.90	--	95	
Varyk II	Olig. II (III)	O	5.200	5.1	0.120	0.26	71.10	--	96	238.00
Varyk II	Eoc. IV	O	5.200	3.0	0.180	0.38	72.00	--	118	
Varyk II	Eoc. VII	O	5.200	9.8	0.120	0.29	58.07	--	119	
Total 53 fields and field-combinations	177 reservoirs	121 O-GO-OG 56 G-GC reservoirs								

Notes: At least 7 additional fields exist (1993 Uzbek & Petroconsultants information), which were probably discovered after 1987.

Volumetric calculations used piecemeal data sources and estimates. Some of the most sensitive data to calculations (reservoir area and thickness), were the least reliable.

Listing of fields in the central basin graben is from Glumakov, et al, 1988; not all are deep-basin.

Initial field discovery year used for all reservoirs in that field.

For Mingbulak field, data listed with 1983* (asterisk) discovery year relate to estimates following the 1992 oil blowout.

Totals may not equal sum of components due to independent rounding. Other calculations also use complete values rather than the rounded values shown.

N-E-S-W as directions of north, east, south, and west.

? = particularly questionable.

Pay Zones as Plioc., Mioc., Olig., Eoc., Paleoc. are epochs of Tertiary Period (Pliocene, Miocene, Oligocene, Eocene, Paleocene). U. and L. Cret. are Upper and Lower Cretaceous Epochs. Jura. is Jurassic Period and Permo-Trias. is a composite zone of the Permian-Triassic Periods.

Pet. Type as petroleum in the reservoir; O = oil, G = natural gas, GC = gas condensate; when GO or OG is listed, the last letter indicates dominance in the pay.

Units as sq km = square kilometers; m = meters; frac = decimal fraction; MPa = million pascals (uncorrected for absolute); deg C = degrees Celcius. E-15 sq m = permeability term for 0.001 square micrometer (which is approximately one millidarcy -- see Table A3).

Source: Energy Information Administration, Office of Oil and Gas.

Table E4. Selected Oil Parameter Estimates, by Reservoir for Fields Discovered through 1987, Fergana Basin (Metric Units)

Field Name	Pay Zone Identification	Petro-leum Type	Oil Density (stmt/stcm)	Initial Oil Formation Volume Factor (cm/stcm)	Oil Reservoir Richness (recoverable stmt/ha-m)	Total Primary Oil Recovery Efficiency (frac)	Primary Ultimate Recoverable Oil (MMstmt)	Improved Recovery Oil, via Waterflood (MMstmt)
North Basin Flank								
Bedresay	L. Cret. XVIIIg	G	--	--	--	--	--	--
Izbaskent	Olig. II (III)	O	0.8654	1.167	149.726	0.17	0.179	0.000
Izbaskent	Eoc. V-VII	O	0.8550	1.198	69.881	0.08	0.130	0.000
Izbaskent	Paleoc. IX	O	0.8576	1.200	129.296	0.18	0.241	0.000
Izbaskent	Paleoc. X	O	0.8576	1.204	135.969	0.19	0.253	0.000
Izbaskent	U. Cret. XII	G	--	--	--	--	--	--
Izbaskent	U. Cret. XIII	G	--	--	--	--	--	--
Izbaskent	U. Cret. XIV	G	--	--	--	--	--	--
Izbaskent	U. Cret. XV	G	--	--	--	--	--	--
Izbaskent	L. Cret. XVIII	G	--	--	--	--	--	--
Kassansay	Olig. II (III)	O	0.8602	1.287	382.324	0.55	1.118	0.000
Kyzyl-Alma	Jura. XXIII	G	--	--	--	--	--	--
Maylisay	Eoc. V	O	0.8681	1.094	185.872	0.32	0.268	0.000
Maylisu III	Olig. II (III)	O	0.8602	1.303	171.604	0.17	0.307	0.145
Maylisu III	Eoc. V	O	0.8550	1.319	121.541	0.17	0.179	0.084
Maylisu III	Eoc. VII	O	0.8550	1.353	53.834	0.07	0.115	0.049
Maylisu III	U. Cret. XIII	G	--	--	--	--	--	--
Maylisu III	U. Cret. XVII	G	--	--	--	--	--	--
Maylisu III	L. Cret. XVIIIa	G	--	--	--	--	--	--
Maylisu III	Jura. XXIII	G	--	--	--	--	--	--
Maylisu IV-Izbaskent, Vost. (E)	Mioc. kkr	O	0.8708	1.106	157.657	0.15	2.438	1.138
Maylisu IV-Izbaskent, Vost. (E)	Olig. II (III)	O	0.8708	1.099	62.444	0.09	1.659	0.000
Maylisu IV-Izbaskent, Vost. (E)	Eoc. V	O	0.8628	1.130	57.933	0.10	0.630	0.000
Maylisu IV-Izbaskent, Vost. (E)	Eoc. VIIa	O	0.8628	1.145	57.200	0.10	0.519	0.000
Maylisu IV-Izbaskent, Vost. (E)	Paleoc. IX	O	0.8654	1.156	132.406	0.17	0.120	0.000
Maylisu IV-Izbaskent, Vost. (E)	U. Cret. XIII	GO	0.8109	1.276	309.178	0.32	1.594	0.797
Maylisu IV-Izbaskent, Vost. (E)	U. Cret. XIV	GO	0.8109	1.275	153.788	0.21	0.284	0.135
Maylisu IV-Izbaskent, Vost. (E)	U. Cret. XV	G	--	--	--	--	--	--
Maylisu IV-Izbaskent, Vost. (E)	U. Cret. XVI	G	--	--	--	--	--	--
Maylisu IV-Izbaskent, Vost. (E)	U. Cret. XVII	G	--	--	--	--	--	--
Maylisu IV-Izbaskent, Vost. (E)	L. Cret. XVIII	GC	--	--	--	--	--	--
Maylisu IV-Izbaskent, Vost. (E)	L. Cret. XIX	G	--	--	--	--	--	--
Maylisu IV-Izbaskent, Vost. (E)	L. Cret. XXII	G	--	--	--	--	--	--
Maylisu IV-Izbaskent, Vost. (E)	Jura. XXIII	G	--	--	--	--	--	--
Namangan	Eoc. V	O	0.8498	1.406	38.332	0.13	0.251	0.000
Shorbulak	Eoc. V	O	0.8448	1.416	192.359	0.43	0.475	0.000
Tergachi	Mioc. kkr	O	0.8448	1.281	307.163	0.58	4.792	0.000
Tergachi	Eoc. V	O	0.8448	1.378	165.913	0.41	0.501	0.000
South Flank - NE of Fergana								
Alamyshik, Sever. (N)	Olig. II (III)	O	0.8299	1.244	161.346	0.21	1.376	0.000
Alamyshik, Yuzh. (S)	Plioc. I+Ia	O	0.8299	1.144	103.418	0.08	0.541	0.271
Alamyshik, Yuzh. (S)	Plioc. Ib	O	0.8299	1.121	263.850	0.20	1.235	0.618
Alamyshik, Yuzh. (S)	Mioc. Ic	O	0.8299	1.116	281.206	0.20	0.693	0.346
Alamyshik, Yuzh. (S)	Olig. II (III)	O	0.8299	1.079	276.993	0.20	0.696	0.348
Alamyshik, Yuzh. (S)	Eoc. V-VII	O	0.8299	1.075	75.276	0.09	0.211	0.094
Alamyshik, Yuzh. (S)	L. Cret. XVIII	O	0.8155	1.128	178.416	0.22	0.637	0.000
Alamyshik, Yuzh. (S)	L. Cret. XIX-XXII	O	0.8109	1.136	163.185	0.23	0.137	0.000
Alamyshik, Yuzh. (S)	Jura. XXIII	GO	0.8063	1.182	100.375	0.23	0.070	0.000
Andizhan	Plioc. I	GO	0.8654	1.123	86.555	0.16	0.305	0.000
Andizhan	Olig. III	GO	0.8550	1.254	184.091	0.25	0.523	0.000
Andizhan	Eoc. V	GO	0.8498	1.343	66.820	0.08	0.042	0.000
Andizhan	Eoc. VI	GO	0.8498	1.358	59.473	0.08	0.037	0.000
Andizhan	Eoc. VII	GO	0.8448	1.412	57.724	0.08	0.068	0.000
Andizhan	Paleoc. VIII	G	--	--	--	--	--	--
Boston	Plioc. I	O	0.8519	1.040	258.027	0.17	0.619	0.291
Boston	Mioc. Ia	O	0.8519	1.094	192.773	0.17	0.534	0.251

Table E4. Selected Oil Parameter Estimates, by Reservoir for Fields Discovered through 1987, Fergana Basin (Metric Units) Continued

Field Name	Pay Zone Identification	Petro-leum Type	Oil Density (stmt/stcm)	Initial Oil Formation Volume Factor (cm/stcm)	Oil Reservoir Richness (recoverable stmt/ha-m)	Total Primary Oil Recovery Efficiency (frac)	Primary Ultimate Recoverable Oil (MMstmt)	Improved Recovery Oil, via Waterflood (MMstmt)
Boston	Mioc. I	O	0.8519	1.165	195.462	0.18	0.715	0.358
Boston	Olig. II (III)	O	0.8529	1.095	222.081	0.18	0.476	0.238
Boston	Olig. III	O	0.8529	1.151	214.477	0.18	0.306	0.153
Boston	L. Cret. XIX	G	--	--	--	--	--	--
Boston	L. Cret. XX+XXI+XXII	GO	0.8109	1.305	95.262	0.21	0.166	0.000
Boston	Jura. XXVII	G	--	--	--	--	--	--
Boston	Permo-Trias. XXX	O	0.8603	1.394	56.157	0.14	0.019	0.000
Changyrtash	Olig. III	O	0.8654	1.192	221.432	0.17	1.084	0.510
Changyrtash	Eoc. V	O	0.8550	1.146	77.219	0.07	0.162	0.069
Chigirchik	Jura. XXIII	O	0.8602	1.058	322.073	0.48	3.768	0.000
Khartum	Olig. III	O	0.8251	1.256	158.931	0.21	0.292	0.000
Khartum	Eoc. VI	O	0.8251	1.366	122.877	0.23	0.226	0.000
Khartum	Eoc. VII	G	--	--	--	--	--	--
Khartum	L. Cret. XXII	GO	0.8063	1.519	73.856	0.14	0.217	0.000
Khartum, Vost. (E)	Olig. II-III	O	0.8251	1.270	263.560	0.39	1.079	0.000
Khartum. Vost. (E)	Eoc. VI	G	--	--	--	--	--	--
Khodzhaosman	L. Cret. XVIII	O	0.8251	1.149	175.217	0.20	0.108	0.000
Palvantash	Plioc. I + Olig. III	O	0.8708	1.021	182.689	0.34	0.215	0.000
Palvantash	Eoc. IV-VI	GO	0.8550	1.030	310.788	0.30	1.414	0.000
Palvantash	Eoc. VII-VIII	GO	0.8550	1.052	321.803	0.30	1.095	0.000
Palvantash	U. Cret. XIII+XIV	G	--	--	--	--	--	--
Palvantash	L. Cret. XVIIIg	G	--	--	--	--	--	--
Palvantash, Zap. (W)	Mioc. bgr	O	0.8299	1.084	421.818	0.51	3.189	0.000
Palvantash, Zap. (W)	Olig. IIIb	O	0.8762	1.064	371.139	0.47	1.351	0.000
Palvantash, Zap. (W)	Eoc. V+VI	O	0.8762	1.200	270.600	0.52	0.495	0.000
Palvantash, Zap. (W)	Eoc. VII	O	0.8762	1.145	323.073	0.35	0.269	0.000
Palvantash, Zap. (W)	Eoc. VIII-IX	O	0.8762	1.202	369.373	0.42	0.279	0.000
Sharikhan-Khodzhiabad	Olig. II-III	O	0.8550	1.128	203.138	0.17	0.921	0.433
Sharikhan-Khodzhiabad	Eoc. V	O	0.8348	1.130	74.443	0.09	0.117	0.000
Sharikhan-Khodzhiabad	Eoc. VI	G	--	--	--	--	--	--
Sharikhan-Khodzhiabad	Eoc. VII	O	0.8348	1.125	86.799	0.09	1.374	0.000
Sharikhan-Khodzhiabad	Eoc. VIII	GO	0.8550	1.277	301.172	0.42	2.867	0.000
Sharikhan-Khodzhiabad	L. Cret. XIX-XXII	GO	0.8155	1.324	342.152	0.56	8.584	0.000
Sharikhan-Khodzhiabad	Jura. XXIII-XXIX	GO	0.8109	1.326	218.107	0.47	2.052	0.000
Suzak	L. Cret. XIX	G	--	--	--	--	--	--
Suzak	L. Cret. XXI	G	--	--	--	--	--	--
South Flank - SW of Fergana								
Aksaray	Eoc. VII	G	--	--	--	--	--	--
Aksaray	Paleoc. VIII	G	--	--	--	--	--	--
Avval'	Eoc. V	O	0.8448	1.121	439.283	0.49	0.874	0.000
Avval', Vost. (E)	Eoc. V	O	0.8498	1.110	317.064	0.40	0.297	0.000
Ayritan	Olig. II (III)	GO	0.8473	1.120	27.016	0.06	0.038	0.000
Ayritan	Eoc. V	O	0.8473	1.144	42.407	0.06	0.059	0.000
Ayritan	Eoc. VII	O	0.8423	1.129	98.479	0.08	0.265	0.133
Ayritan	Paleoc. IX	G	--	--	--	--	--	--
Beshkent-Togap	Olig. II (III)	O	0.8708	1.069	205.322	0.17	0.735	0.346
Chaur-Yarkutan-Chimion	Eoc. IV	O	0.8672	1.049	207.334	0.15	0.623	0.291
Chaur-Yarkutan-Chimion	Eoc. V, VI	O	0.8708	1.053	229.236	0.16	1.011	0.505
Chongara-Gal'cha	Eoc. IV	GO	0.8708	1.501	140.906	0.22	4.685	0.000
Chongara-Gal'cha	Eoc. V	G	--	--	--	--	--	--
Chongara-Gal'cha	Eoc. VII	G	--	--	--	--	--	--
Karagachi-Tamchi	Eoc. IV	O	0.8602	1.317	270.913	0.29	7.322	0.000
Khankyz	Olig. II (III)	O	0.8816	1.057	249.524	0.32	0.505	0.000
Khankyz	Eoc. VII	O	0.8984	1.056	363.731	0.38	1.964	0.000
Khankyz	L. Cret. XVIII	G	--	--	--	--	--	--
Kim (Sel'rokho)	Olig. II (III)	O	0.8550	1.107	271.870	0.17	1.514	0.713
Kim (Sel'rokho)	Eoc. V	O	0.8448	1.129	87.548	0.08	0.526	0.263
Kim (Sel'rokho)	Eoc. VI	O	0.8448	1.133	237.558	0.18	2.421	1.211

Table E4. Selected Oil Parameter Estimates, by Reservoir for Fields Discovered through 1987, Fergana Basin (Metric Units) Continued

Field Name	Pay Zone Identification	Petro-leum Type	Oil Density (stmt/stcm)	Initial Oil Formation Volume Factor (cm/stcm)	Oil Reservoir Richness (recoverable stmt/ha-m)	Total Primary Oil Recovery Efficiency (frac)	Primary Ultimate Recoverable Oil (MMstmt)	Improved Recovery Oil, via Waterflood (MMstmt)
Kim (Sel'rokho)	Eoc. VIa	O	0.8448	1.134	244.992	0.18	1.338	0.669
Kim (Sel'rokho)	Eoc. VII	O	0.8448	1.129	87.515	0.08	1.226	0.613
Nefteabad	Olig. II (III)	GO	0.8498	1.121	64.815	0.10	0.478	0.000
Obi-Shifo	Olig. II-III	O	0.8550	1.108	194.469	0.17	0.387	0.182
Rishtan, Sever. (N)	U. Cret. XIV	G	--	--	--	--	--	--
Rishtan, Sever. (N)	U. Cret. XVI + XVII	O	0.8498	1.158	148.605	0.18	0.322	0.161
Rishtan, Sever. (N)	L. Cret. XVIIIg	G	--	--	--	--	--	--
Rishtan, Sever. (N)	Jura. XXIII-XXIX	G	--	--	--	--	--	--
Sarykamysh	U. Cret. XIV	G	--	--	--	--	--	--
Sarykamysh	L. Cret. XVII	G	--	--	--	--	--	--
Sarykamysh	Jura. XXIII	G	--	--	--	--	--	--
Sarytok	Jura. XXVI	G	--	--	--	--	--	--
Shorsu IV	Olig. II (III)	O	0.8602	1.080	221.024	0.17	0.258	0.121
Shorsu IV	Eoc. IV	O	0.8550	1.102	236.832	0.17	0.138	0.065
Shorsu IV	Eoc. V	OG	0.8498	1.113	54.241	0.08	0.047	0.000
Shorsu IV	Eoc. VI	O	0.8498	1.108	252.846	0.18	0.145	0.072
Shorsu IV	Eoc. VII	O	0.8602	1.104	79.475	0.07	0.194	0.083
Shorsu IV	Paleoc. VIII	O	0.8654	1.116	72.737	0.07	0.054	0.023
Shorsu IV	Paleoc. IX	O	0.8708	1.128	186.203	0.16	0.107	0.053
Shorsu VI	Eoc. VII	G	--	--	--	--	--	--
Sokh, Sever. (N)	Olig. II	OG	0.8498	1.120	173.021	0.19	1.763	0.000
Sokh, Sever. (N)	Eoc. IV	GO	0.8498	1.116	102.641	0.09	0.155	0.069
Sokh, Sever. (N)	Eoc. V	GC	--	--	--	--	--	--
Sokh, Sever. (N)	Eoc. VII	G	--	--	--	--	--	--
Sokh, Sever. (N)	Paleoc. VIII	O	0.8448	1.134	102.869	0.09	0.518	0.230
Sokh, Sever. (N)	U. Cret. XIV-XV	GO	0.8398	1.265	75.135	0.11	0.707	0.000
Sokh, Sever. (N)	L. Cret. XVIIIg	GC	--	--	--	--	--	--
Sokh, Sever. (N)	L. Cret. XXII	GC	--	--	--	--	--	--
Sokh, Sever. (N)	Jura. XXIV-XXV	GC	--	--	--	--	--	--
Tasravet	Eoc. IV	O	0.8398	1.153	224.183	0.19	0.269	0.113
Central Basin Graben								
Achisu	Olig. II (III)	O	0.8448	1.237	148.591	0.20	0.464	0.000
Gumkhana	Plioc. I	O	0.8550	1.468	69.890	0.16	0.818	0.000
Gumkhana	Mioc.(?)	O	0.8550	1.512	63.615	0.15	1.892	0.000
Kanibadam	Eoc. V	O	0.8654	1.237	57.313	0.08	0.064	0.000
Kanibadam	Eoc. VII	O	0.8654	1.232	61.655	0.09	0.208	0.000
Kanibadam	Paleoc. IX+IXa	GC	--	--	--	--	--	--
Kanibadam, Sever. (N)	Olig. II (III)	O	0.8299	1.273	149.001	0.21	0.356	0.000
Madaniyat	Olig. II	O	0.8602	1.236	151.379	0.20	0.443	0.000
Madaniyat	Eoc. IV	O	0.8602	1.248	146.123	0.19	0.427	0.000
Madaniyat	Eoc. VII	O	0.8602	1.235	148.540	0.20	1.318	0.000
Makhram	Olig. II-III	O	0.8448	1.257	146.228	0.20	0.257	0.000
Mingbulak	Mioc. kkp	O	0.8752	1.600	125.154	0.16	15.449	0.000
Mingbulak	Oilg. III	O	0.8498	1.724	102.534	0.16	4.319	0.000
Mingbulak	Paleoc. VIII	O	0.8150	1.744	72.901	0.16	2.834	0.000
Mingbulak	Paleoc. IX	GC	--	--	--	--	--	--
Niyazbek-Karakchikum	Olig. II (III)	O	0.8602	1.278	151.900	0.20	1.307	0.000
Niyazbek-Karakchikum	Eoc. IV	O	0.8602	1.303	147.331	0.20	0.928	0.000
Niyazbek-Karakchikum	Eoc. V	O	0.8602	1.301	67.448	0.10	0.302	0.000
Niyazbek-Karakchikum	Eoc. VI	GC	--	--	--	--	--	--
Niyazbek-Karakchikum	Eoc. VIIa	GC	--	--	--	--	--	--
Niyazbek-Karakchikum	Paleoc. IX	GC	--	--	--	--	--	--
Niyazbek-Karakchikum	U. Cret. XI-XII	GC	--	--	--	--	--	--
Ravat	Olig. II (III)	O	0.8251	1.812	290.151	0.59	1.414	0.000
Ravat	Eoc. IV	O	0.8816	1.124	232.870	0.33	1.059	0.000
Ravat	Eoc. V	GC	--	--	--	--	--	--
Ravat	Eoc. VII	O	0.8708	1.372	253.862	0.43	0.618	0.000
Ravat	Paleoc. IX-IXa	GC	--	--	--	--	--	--

Table E4. Selected Oil Parameter Estimates, by Reservoir for Fields Discovered through 1987, Fergana Basin (Metric Units) Continued

Field Name	Pay Zone Identification	Petro-leum Type	Oil Density (stmt/stcm)	Initial Oil Formation Volume Factor (cm/stcm)	Oil Reservoir Richness (recoverable stmt/ha-m)	Total Primary Oil Recovery Efficiency (frac)	Primary Ultimate Recoverable Oil (MMstmt)	Improved Recovery Oil, via Waterflood (MMstmt)
Varyk	Olig. II (III)	O	0.8251	1.276	147.762	0.21	0.778	0.000
Varyk	Eoc. IV	O	0.8708	1.363	135.435	0.19	0.396	0.000
Varyk	Eoc. V	G	--	--	--	--	--	--
Varyk	Eoc. VII	O	0.8628	1.352	55.993	0.09	0.497	0.000
Varyk	Paleoc. IX	O	0.8602	1.355	134.636	0.19	0.985	0.000
Varyk II	Olig. II (III)	O	0.8203	1.345	124.547	0.23	0.330	0.000
Varyk II	Eoc. IV	O	0.8448	1.369	96.435	0.14	0.150	0.000
Varyk II	Eoc. VII	O	0.8448	1.375	47.118	0.09	0.240	0.000
Total 53 fields and field-combinations	177 reservoirs	121 O-GO-OG 56 G-GC reservoirs					125.418 MMstmt Pri. Oil	12.246 MMstmt Wf. Oil

Notes: At least 7 additional fields exist (1993 Uzbek & Petroconsultants information), which were probably discovered after 1987.

Volumetric calculations used piecemeal data sources and estimates. Some of the most sensitive data to calculations (reservoir area and thickness), were the least reliable.

Listing of fields in the central basin graben is from Glumakov, et al, 1988; not all are deep-basin.

Initial field discovery year used for all reservoirs in that field.

For Mingbulak field, data listed with 1983* (asterisk) discovery year relate to estimates following the 1992 oil blowout.

Totals may not equal sum of components due to independent rounding. Other calculations also use complete values rather than the rounded values shown.

N-E-S-W as directions of north, east, south, and west.

Pay Zones as Plioc., Mioc., Olig., Eoc., Paleoc. are epochs of Tertiary Period (Pliocene, Miocene, Oligocene, Eocene, Paleocene). U. an L. Cret. are Upper and Lower Cretaceous Epochs. Jura. is Jurassic Period and Permo-Trias. is a composite zone of the Permian-Triassic Periods.

Petroleum Type as that in the reservoir; O = oil, G = natural gas, GC = gas condensate; when GO or OG is listed, the last letter indicates dominance.

Density in metric tons per cubic meter oil or grams per milliliter oil (specific gravity), basically stock tank conditions.

Richness as recoverable metric tons of stock tank oil per hectare-meter of reservoir bulk volume.

Units as MMstmt = million stock tank metric tons oil; cm/stcm = oil formation volume factor, cubic meters reservoir oil per stock tank cubic meter oil. These "stock tank" units represent surface conditions.

Primary (pri.) = oil recovery mechanism, including liquid expansion; frac = decimal fraction; Waterflood (Wf.) = improved oil recovery by waterflood.

Source: Energy Information Administration, Office of Oil and Gas.

Table E5. Selected Gas Parameter Estimates, by Reservoir for Fields Discovered through 1987, Fergana Basin (Metric Units)

Field Name	Pay Zone Identification	Petro-leum Type	Gas Gravity (air=1.0)	Initial Gas Formation Volume Factor (cm/scm)	NA Gas Recovery Efficiency (frac)	Initial Gas-Oil Ratio, GOR (scm/stmt)	Ultimate Recoverable Primary A-D Gas (MMscm)	Ultimate Recoverable Waterflood A-D Gas (MMscm)
North Basin Flank								
Bedresay	L. Cret. XVIIIg	G	0.6670	0.003635	0.73	--	--	--
Izbaskent	Olig. II (III)	O	0.9420	--	--	70.0	12.546	0.000
Izbaskent	Eoc. V-VII	O	0.9420	--	--	82.0	10.670	0.000
Izbaskent	Paleoc. IX	O	0.8500	--	--	78.0	18.778	0.000
Izbaskent	Paleoc. X	O	0.8500	--	--	80.0	20.254	0.000
Izbaskent	U. Cret. XII	G	0.6670	0.003714	0.77	--	--	--
Izbaskent	U. Cret. XIII	G	0.6210	0.003994	0.75	--	--	--
Izbaskent	U. Cret. XIV	G	0.6670	0.003775	0.73	--	--	--
Izbaskent	U. Cret. XV	G	0.6670	0.003729	0.72	--	--	--
Izbaskent	L. Cret. XVIII	G	0.6670	0.003732	0.71	--	--	--
Kassansay	Olig. II (III)	O	0.8260	--	--	115.0	128.604	0.000
Kyzyl-Alma	Jura. XXIII	G	0.6670	0.003859	0.74	--	--	--
Maylisay	Eoc. V	O	0.8500	--	--	38.0	10.192	0.000
Maylisu III	Olig. II (III)	O	0.8260	--	--	110.0	33.791	15.902
Maylisu III	Eoc. V	O	0.8500	--	--	130.0	23.256	10.944
Maylisu III	Eoc. VII	O	0.8500	--	--	130.0	14.902	6.387
Maylisu III	U. Cret. XIII	G	0.6670	0.008735	0.84	--	--	--
Maylisu III	U. Cret. XVII	G	0.6670	0.005497	0.84	--	--	--
Maylisu III	L. Cret. XVIIIa	G	0.6670	0.005097	0.84	--	--	--
Maylisu III	Jura. XXIII	G	0.6670	0.004031	0.81	--	--	--
Maylisu IV-Izbaskent, Vost. (E)	Mioc. kkr	O	1.0310	--	--	40.0	97.518	45.508
Maylisu IV-Izbaskent, Vost. (E)	Olig. II (III)	O	0.9140	--	--	41.5	68.841	0.000
Maylisu IV-Izbaskent, Vost. (E)	Eoc. V	O	0.9140	--	--	50.0	31.510	0.000
Maylisu IV-Izbaskent, Vost. (E)	Eoc. VIIa	O	0.8500	--	--	55.5	28.778	0.000
Maylisu IV-Izbaskent, Vost. (E)	Paleoc. IX	O	0.8500	--	--	60.0	7.229	0.000
Maylisu IV-Izbaskent, Vost. (E)	U. Cret. XIII	GO	0.6560	--	--	115.0	183.348	91.674
Maylisu IV-Izbaskent, Vost. (E)	U. Cret. XIV	GO	0.6560	--	--	115.0	32.707	15.575
Maylisu IV-Izbaskent, Vost. (E)	U. Cret. XV	G	0.6670	0.004951	0.81	--	--	--
Maylisu IV-Izbaskent, Vost. (E)	U. Cret. XVI	G	0.6670	0.004993	0.80	--	--	--
Maylisu IV-Izbaskent, Vost. (E)	U. Cret. XVII	G	0.6470	0.004758	0.80	--	--	--
Maylisu IV-Izbaskent, Vost. (E)	L. Cret. XVIII	GC	0.6470	0.004387	0.80	--	--	--
Maylisu IV-Izbaskent, Vost. (E)	L. Cret. XIX	G	0.6670	0.003469	0.82	--	--	--
Maylisu IV-Izbaskent, Vost. (E)	L. Cret. XXII	G	0.6670	0.003461	0.80	--	--	--
Maylisu IV-Izbaskent, Vost. (E)	Jura. XXIII	G	0.6670	0.003698	0.79	--	--	--
Namangan	Eoc. V	O	0.9550	--	--	176.0	44.155	0.000
Shorbulak	Eoc. V	O	0.8500	--	--	175.0	83.147	0.000
Tergachi	Mioc. kkr	O	1.0310	--	--	120.0	575.009	0.000
Tergachi	Eoc. V	O	0.8500	--	--	140.0	70.206	0.000
South Flank - NE of Fergana								
Alamyshik, Sever. (N)	Olig. II (III)	O	0.8260	--	--	100.0	137.648	0.000
Alamyshik, Yuzh. (S)	Plioc. I+Ia	O	1.1200	--	--	60.0	32.490	16.245
Alamyshik, Yuzh. (S)	Plioc. Ib	O	1.1200	--	--	50.0	61.762	30.881
Alamyshik, Yuzh. (S)	Mioc. Ic	O	1.1200	--	--	47.0	32.566	16.283
Alamyshik, Yuzh. (S)	Olig. II (III)	O	1.1200	--	--	30.0	20.871	10.435
Alamyshik, Yuzh. (S)	Eoc. V-VII	O	1.1200	--	--	28.0	5.920	2.631
Alamyshik, Yuzh. (S)	L. Cret. XVIII	O	0.7525	--	--	40.0	25.478	0.000
Alamyshik, Yuzh. (S)	L. Cret. XIX-XXII	O	0.7525	--	--	50.0	6.854	0.000
Alamyshik, Yuzh. (S)	Jura. XXIII	GO	0.7525	--	--	70.0	4.918	0.000
Andizhan	Plioc. I	GO	1.0310	--	--	50.0	15.268	0.000
Andizhan	Olig. III	GO	0.8240	--	--	105.0	54.935	0.000
Andizhan	Eoc. V	GO	0.8550	--	--	145.0	6.104	0.000
Andizhan	Eoc. VI	GO	0.8550	--	--	150.0	5.620	0.000
Andizhan	Eoc. VII	GO	0.8550	--	--	175.4	11.907	0.000
Andizhan	Paleoc. VIII	G	0.8550	0.010744	0.74	--	--	--
Boston	Plioc. I	O	0.6870	--	--	11.0	6.809	3.204
Boston	Mioc. Ia	O	1.1500	--	--	40.0	21.376	10.059

Table E5. Selected Gas Parameter Estimates, by Reservoir for Fields Discovered through 1987, Fergana Basin (Metric Units) Continued

Field Name	Pay Zone Identification	Petro-leum Type	Gas Gravity (air=1.0)	Initial Gas Formation Volume Factor (cm/scm)	NA Gas Recovery Efficiency (frac)	Initial Gas-Oil Ratio, GOR (scm/stmt)	Ultimate Recoverable Primary A-D Gas (MMscm)	Ultimate Recoverable Waterflood A-D Gas (MMscm)
Boston	Mioc. I	O	1.1500	--	--	69.0	49.344	24.672
Boston	Olig. II (III)	O	0.8580	--	--	40.0	19.036	9.518
Boston	Olig. III	O	0.8580	--	--	60.0	18.376	9.188
Boston	L. Cret. XIX	G	0.6500	0.004004	0.78	--	--	--
Boston	L. Cret. XX+XXI+XXII	GO	0.6790	--	--	121.0	20.139	0.000
Boston	Jura. XXVII	G	0.6670	0.003515	0.79	--	--	--
Boston	Permo-Trias. XXX	O	0.6790	--	--	150.0	2.830	0.000
Changyrtash	Olig. III	O	0.8450	--	--	67.5	73.179	34.437
Changyrtash	Eoc. V	O	0.7920	--	--	57.7	9.357	4.010
Chigirchik	Jura. XXIII	O	0.6790	--	--	15.0	56.524	0.000
Khartum	Olig. III	O	0.8260	--	--	105.0	30.664	0.000
Khartum	Eoc. VI	O	0.7580	--	--	149.8	33.823	0.000
Khartum	Eoc. VII	G	0.7560	0.003993	0.74	--	--	--
Khartum	L. Cret. XXII	GO	0.6790	--	--	200.0	43.427	0.000
Khartum, Vost. (E)	Olig. II-III	O	0.6850	--	--	110.0	118.721	0.000
Khartum. Vost. (E)	Eoc. VI	G	0.7080	0.003343	0.81	--	--	--
Khodzhaosman	L. Cret. XVIII	O	0.6790	--	--	58.0	6.260	0.000
Palvantash	Plioc. I + Olig. III	O	1.0200	--	--	5.0	1.074	0.000
Palvantash	Eoc. IV-VI	GO	0.9490	--	--	7.0	9.899	0.000
Palvantash	Eoc. VII-VIII	GO	0.8490	--	--	15.0	16.422	0.000
Palvantash	U. Cret. XIII+XIV	G	0.6910	0.006776	0.85	--	--	--
Palvantash	L. Cret. XVIIIg	G	0.6900	0.004804	0.79	--	--	--
Palvantash, Zap. (W)	Mioc. bgr	O	1.0900	--	--	29.0	92.479	0.000
Palvantash, Zap. (W)	Olig. IIIb	O	1.0040	--	--	12.0	16.211	0.000
Palvantash, Zap. (W)	Eoc. V+VI	O	0.9740	--	--	78.0	38.615	0.000
Palvantash, Zap. (W)	Eoc. VII	O	1.0190	--	--	50.0	13.433	0.000
Palvantash, Zap. (W)	Eoc. VIII-IX	O	1.0650	--	--	80.0	22.340	0.000
Sharikhan-Khodzhiabad	Olig. II-III	O	0.8260	--	--	50.0	46.026	21.659
Sharikhan-Khodzhiabad	Eoc. V	O	0.7670	--	--	49.9	5.825	0.000
Sharikhan-Khodzhiabad	Eoc. VI	G	0.7670	0.013073	0.79	--	--	--
Sharikhan-Khodzhiabad	Eoc. VII	O	0.8500	--	--	49.9	68.551	0.000
Sharikhan-Khodzhiabad	Eoc. VIII	GO	0.7600	--	--	100.0	286.715	0.000
Sharikhan-Khodzhiabad	L. Cret. XIX-XXII	GO	0.6745	--	--	122.3	1049.813	0.000
Sharikhan-Khodzhiabad	Jura. XXIII-XXIX	GO	0.6790	--	--	130.0	266.753	0.000
Suzak	L. Cret. XIX	G	0.6670	0.004830	0.78	--	--	--
Suzak	L. Cret. XXI	G	0.6670	0.003725	0.82	--	--	--
South Flank - SW of Fergana								
Aksaray	Eoc. VII	G	0.7010	0.012323	0.78	--	--	--
Aksaray	Paleoc. VIII	G	0.7010	0.009977	0.76	--	--	--
Avval'	Eoc. V	O	0.8500	--	--	47.0	41.066	0.000
Avval', Vost. (E)	Eoc. V	O	0.8500	--	--	40.0	11.871	0.000
Ayritan	Olig. II (III)	GO	0.8260	--	--	44.0	1.657	0.000
Ayritan	Eoc. V	O	0.8500	--	--	48.0	2.838	0.000
Ayritan	Eoc. VII	O	0.8500	--	--	55.0	14.600	7.300
Ayritan	Paleoc. IX	G	0.7010	0.005702	0.78	--	--	--
Beshkent-Togap	Olig. II (III)	O	0.8260	--	--	20.0	14.702	6.919
Chaur-Yarkutan-Chimion	Eoc. IV	O	0.8500	--	--	15.0	9.349	4.363
Chaur-Yarkutan-Chimion	Eoc. V, VI	O	0.8500	--	--	18.0	18.192	9.096
Chongara-Gal'cha	Eoc. IV	GO	0.6880	--	--	211.5	990.904	0.000
Chongara-Gal'cha	Eoc. V	G	0.6500	0.023174	0.78	--	--	--
Chongara-Gal'cha	Eoc. VII	G	0.6860	0.022979	0.76	--	--	--
Karagachi-Tamchi	Eoc. IV	O	0.8500	--	--	130.0	951.855	0.000
Khankyz	Olig. II (III)	O	0.6500	--	--	10.0	5.053	0.000
Khankyz	Eoc. VII	O	0.8500	--	--	9.7	19.052	0.000
Khankyz	L. Cret. XVIII	G	0.7140	0.004053	0.76	--	--	--
Kim (Sel'rokho)	Olig. II (III)	O	0.8260	--	--	40.0	60.564	28.501
Kim (Sel'rokho)	Eoc. V	O	0.8500	--	--	50.0	26.291	13.145
Kim (Sel'rokho)	Eoc. VI	O	0.8500	--	--	52.0	125.902	62.951

Table E5. Selected Gas Parameter Estimates, by Reservoir for Fields Discovered through 1987, Fergana Basin (Metric Units) Continued

Field Name	Pay Zone Identification	Petro-leum Type	Gas Gravity (air=1.0)	Initial Gas Formation Volume Factor (cm/scm)	NA Gas Recovery Efficiency (frac)	Initial Gas-Oil Ratio, GOR (scm/stmt)	Ultimate Recoverable Primary A-D Gas (MMscm)	Ultimate Recoverable Waterflood A-D Gas (MMscm)
Kim (Sel'rokho)	Eoc. VIa	O	0.8500	--	--	52.0	69.558	34.779
Kim (Sel'rokho)	Eoc. VII	O	0.8500	--	--	50.0	61.322	30.661
Nefteabad	Olig. II (III)	GO	0.8260	--	--	43.0	20.543	0.000
Obi-Shifo	Olig. II-III	O	0.8260	--	--	40.0	15.472	7.281
Rishtan, Sever. (N)	U. Cret. XIV	G	0.6670	0.015385	0.80	--	--	--
Rishtan, Sever. (N)	U. Cret. XVI + XVII	O	0.6790	--	--	60.0	19.319	9.659
Rishtan, Sever. (N)	L. Cret. XVIIIg	G	0.6670	0.009074	0.80	--	--	--
Rishtan, Sever. (N)	Jura. XXIII-XXIX	G	0.6670	0.006688	0.80	--	--	--
Sarykamysh	U. Cret. XIV	G	0.6670	0.026014	0.82	--	--	--
Sarykamysh	L. Cret. XVII	G	0.6670	0.014229	0.79	--	--	--
Sarykamysh	Jura. XXIII	G	0.6670	0.007613	0.82	--	--	--
Sarytok	Jura. XXVI	G	0.6670	0.007528	0.80	--	--	--
Shorsu IV	Olig. II (III)	O	0.8260	--	--	30.0	7.737	3.641
Shorsu IV	Eoc. IV	O	0.8500	--	--	40.0	5.527	2.601
Shorsu IV	Eoc. V	OG	0.8500	--	--	45.0	2.094	0.000
Shorsu IV	Eoc. VI	O	0.8500	--	--	42.0	6.074	3.037
Shorsu IV	Eoc. VII	O	0.8500	--	--	40.0	7.765	3.328
Shorsu IV	Paleoc. VIII	O	0.8500	--	--	45.0	2.425	1.039
Shorsu IV	Paleoc. IX	O	0.8500	--	--	50.0	5.325	2.663
Shorsu VI	Eoc. VII	G	0.7010	0.031864	0.77	--	--	--
Sokh, Sever. (N)	Olig. II	OG	0.6850	--	--	43.0	75.828	0.000
Sokh, Sever. (N)	Eoc. IV	GO	0.7100	--	--	40.0	6.208	2.759
Sokh, Sever. (N)	Eoc. V	GC	0.6630	0.006094	0.80	--	--	--
Sokh, Sever. (N)	Eoc. VII	G	0.7010	0.005811	0.80	--	--	--
Sokh, Sever. (N)	Paleoc. VIII	O	0.8500	--	--	50.0	25.923	11.521
Sokh, Sever. (N)	U. Cret. XIV-XV	GO	0.6450	--	--	100.0	70.687	0.000
Sokh, Sever. (N)	L. Cret. XVIIIg	GC	0.6660	0.005222	0.77	--	--	--
Sokh, Sever. (N)	L. Cret. XXII	GC	0.6480	0.004650	0.79	--	--	--
Sokh, Sever. (N)	Jura. XXIV-XXV	GC	0.6870	0.003752	0.79	--	--	--
Tasravet	Eoc. IV	O	0.8500	--	--	60.0	16.151	6.800
Central Basin Graben								
Achisu	Olig. II (III)	O	0.8260	--	--	90.0	41.724	0.000
Gumkhana	Plioc. I	O	0.9500	--	--	208.3	170.343	0.000
Gumkhana	Miocene?	O	0.9500	--	--	229.1	433.491	0.000
Kanibadam	Eoc. V	O	0.7680	--	--	88.0	5.613	0.000
Kanibadam	Eoc. VII	O	0.8500	--	--	89.0	18.526	0.000
Kanibadam	Paleoc. IX+IXa	GC	0.6640	0.003763	0.72	--	--	--
Kanibadam, Sever. (N)	Olig. II (III)	O	0.8260	--	--	108.0	38.409	0.000
Madaniyat	Olig. II	O	0.8260	--	--	90.0	39.851	0.000
Madaniyat	Eoc. IV	O	0.8500	--	--	95.0	40.604	0.000
Madaniyat	Eoc. VII	O	0.8500	--	--	90.0	118.613	0.000
Makhram	Olig. II-III	O	0.8260	--	--	100.0	25.663	0.000
Mingbulak	Mioc. kkp	O	0.9510	--	--	267.0	4124.984	0.000
Mingbulak	Olig. III	O	0.9510	--	--	328.6	1419.324	0.000
Mingbulak	Paleoc. VIII	O	0.9510	--	--	342.7	971.340	0.000
Mingbulak	Paleoc. IX	GC	0.7000	0.002570	0.66	--	--	--
Niyazbek-Karakchikum	Olig. II (III)	O	0.8260	--	--	110.0	143.724	0.000
Niyazbek-Karakchikum	Eoc. IV	O	0.8500	--	--	120.0	111.382	0.000
Niyazbek-Karakchikum	Eoc. V	O	0.8500	--	--	120.0	36.260	0.000
Niyazbek-Karakchikum	Eoc. VI	GC	0.7080	0.003046	0.71	--	--	--
Niyazbek-Karakchikum	Eoc. VIIa	GC	0.7010	0.003268	0.69	--	--	--
Niyazbek-Karakchikum	Paleoc. IX	GC	0.7010	0.003265	0.69	--	--	--
Niyazbek-Karakchikum	U. Cret. XI-XII	GC	0.6670	0.003259	0.69	--	--	--
Ravat	Olig. II (III)	O	0.8260	--	--	351.9	497.451	0.000
Ravat	Eoc. IV	O	0.8500	--	--	35.0	37.062	0.000
Ravat	Eoc. V	GC	0.7080	0.003639	0.71	--	--	--
Ravat	Eoc. VII	O	0.6200	--	--	143.2	88.556	0.000
Ravat	Paleoc. IX-IXa	GC	0.7000	0.002961	0.72	--	--	--

Table E5. Selected Gas Parameter Estimates, by Reservoir for Fields Discovered through 1987, Fergana Basin (Metric Units) Continued

Field Name	Pay Zone Identification	Petro-leum Type	Gas Gravity (air=1.0)	Initial Gas Formation Volume Factor (cm/scm)	NA Gas Recovery Efficiency (frac)	Initial Gas-Oil Ratio, GOR (scm/stmt)	Ultimate Recoverable Primary A-D Gas (MMscm)	Ultimate Recoverable Waterflood A-D Gas (MMscm)
Varyk	Olig. II (III)	O	0.8260	--	--	110.0	85.576	0.000
Varyk	Eoc. IV	O	0.8500	--	--	145.0	57.441	0.000
Varyk	Eoc. V	G	0.8500	0.003348	0.69	--	--	--
Varyk	Eoc. VII	O	0.8500	--	--	140.0	69.551	0.000
Varyk	Paleoc. IX	O	0.8500	--	--	141.6	139.409	0.000
Varyk II	Olig. II (III)	O	0.8260	--	--	145.0	47.893	0.000
Varyk II	Eoc. IV	O	0.8500	--	--	150.0	22.566	0.000
Varyk II	Eoc. VII	O	0.8500	--	--	150.0	36.017	0.000
Total 53 fields and field-combinations	177 reservoirs	121 O-GO-OG 56 G-GC reservoirs					15895.032 Pri. MMscm A-D Gas	631.257 Wf. MMscm A-D Gas

Notes: At least 7 additional fields exist (1993 Uzbek & Petroconsultants information), which were probably discovered after 1987.

Volumetric calculations used piecemeal data sources and estimates. Some of the most sensitive data to calculations (reservoir area and thickness), were the least reliable. GORs for Gumkhana and Mingbulak fields are other examples of suspect estimates.

Listing of fields in the central basin graben is from Glumakov, et al, 1988; not all are deep-basin.

Initial field discovery year used for all reservoirs in that field.

For Mingbulak field, data listed with 1983* (asterisk) discovery year relate to estimates following the 1992 oil blowout.

Totals may not equal sum of components due to independent rounding. Other calculations also use complete values rather than the rounded values shown.

N-E-S-W as directions of north, east, south, and west. Pay Zones as Plioc., Mioc., Olig., Eoc., Paleoc. are epochs of Tertiary Period (Pliocene, Miocene, Oligocene, Eocene, Paleocene). U. an L. Cret. are Upper and Lower Cretaceous Epochs. Jura. is Jurassic Period and Permo-Trias. is a composite zone of the Permian-Triassic Periods.

Petroleum Type as that in the reservoir; O = oil, G = natural gas, GC = gas condensate; when GO or OG is listed, the last letter indicates dominance.

Gas Gravity is the specific gas gravity related to air = 1.00.

Units as cm/scm = gas formation factor, cubic meters reservoir gas per standard cubic meter gas; scm/stmt = gas-oil ratio as standard cubic meters gas per stock tank metric ton oil; MMscf = million standard cubic feet gas. These "stock tank" units represent surface conditions.

NA Gas = nonassociated (free) gas; frac = decimal fraction; Primary (pri.) = oil recovery mechanism, including liquid expansion; Waterflood (wf.) = improved oil recovery by waterflood; A-D Gas = associated-and/or-dissolved gas in oil reservoirs or produced with the oil.

Source: Energy Information Administration, Office of Oil and Gas.

Appendix F

Miscellaneous Parameter Estimates

Appendix F

Miscellaneous Parameter Estimates

(English and metric units)

Table F1, with both English and metric units, is the single table in this appendix. The available computer diskette also contains this table as a separate file.

Table F1. Miscellaneous Parameter Estimates, by Reservoir for Fields Discovered through 1987, Fergana Basin (English and Metric Units)

Field Name	Pay Zone Identification	Petro-leum Type	Liquid Expansion Recovery Efficiency (frac)	Improved Oil Recovery Efficiency (waterflood) (frac)	Bubble-point Oil Reservoir Pressure (psi)	Bubble-point Oil Reservoir Pressure (MPa)	Oil FVF at Bubble-pt. Pressure (bbl/stb, cm/stcm)	Gas FVF at Abandonment Pressure (cf/scf, cm/scm)
North Basin Flank								
Bedresay	L. Cret. XVIIIr	G	--	--	--	--	--	0.016645
Izbaskent	Olig. II (III)	O	0.01	0.00	1379	9.51	1.179	--
Izbaskent	Eoc. V-VII	O	0.01	0.00	1518	10.47	1.215	--
Izbaskent	Paleoc. IX	O	0.02	0.00	1683	11.60	1.219	--
Izbaskent	Paleoc. X	O	0.02	0.00	1721	11.87	1.224	--
Izbaskent	U. Cret. XII	G	--	--	--	--	--	0.019561
Izbaskent	U. Cret. XIII	G	--	--	--	--	--	0.019537
Izbaskent	U. Cret. XIV	G	--	--	--	--	--	0.016949
Izbaskent	U. Cret. XV	G	--	--	--	--	--	0.016400
Izbaskent	L. Cret. XVIII	G	--	--	--	--	--	0.015747
Kassansay	Olig. II (III)	O	0.01	0.00	2339	16.12	1.294	--
Kyzyl-Alma	Jura. XXIII	G	--	--	--	--	--	0.017964
Maylisay	Eoc. V	O	0.00	0.00	852	5.87	1.094	--
Maylisu III	Olig. II (III)	O	0.00	0.08	2101	14.48	1.266	--
Maylisu III	Eoc. V	O	0.00	0.08	2273	15.67	1.310	--
Maylisu III	Eoc. VII	O	0.00	0.03	2277	15.70	1.311	--
Maylisu III	U. Cret. XIII	G	--	--	--	--	--	0.057647
Maylisu III	U. Cret. XVII	G	--	--	--	--	--	0.038159
Maylisu III	L. Cret. XVIIIa	G	--	--	--	--	--	0.037655
Maylisu III	Jura. XXIII	G	--	--	--	--	--	0.025582
Maylisu IV-Izbaskent, Vost. (E)	Mioc. kkp	O	0.00	0.07	834	5.75	1.110	--
Maylisu IV-Izbaskent, Vost. (E)	Olig. II (III)	O	0.00	0.00	876	6.04	1.100	--
Maylisu IV-Izbaskent, Vost. (E)	Eoc. V	O	0.01		97	0.67	1.137	--
Maylisu IV-Izbaskent, Vost. (E)	Eoc. VIIa	O	0.01		98	0.67	1.151	--
Maylisu IV-Izbaskent, Vost. (E)	Paleoc. IX	O	0.01	0.00	1338	9.23	1.162	--
Maylisu IV-Izbaskent, Vost. (E)	U. Cret. XIII	GO	0.00	0.16	1810	12.48	1.282	--
Maylisu IV-Izbaskent, Vost. (E)	U. Cret. XIV	GO	0.01	0.10	1818	12.54	1.284	--
Maylisu IV-Izbaskent, Vost. (E)	U. Cret. XV	G	--	--	--	--	--	0.028947
Maylisu IV-Izbaskent, Vost. (E)	U. Cret. XVI	G	--	--	--	--	--	0.028956
Maylisu IV-Izbaskent, Vost. (E)	U. Cret. XVII	G	--	--	--	--	--	0.027346
Maylisu IV-Izbaskent, Vost. (E)	L. Cret. XVIII	GC	--	--	--	--	--	0.025720
Maylisu IV-Izbaskent, Vost. (E)	L. Cret. XIX	G	--	--	--	--	--	0.023859
Maylisu IV-Izbaskent, Vost. (E)	L. Cret. XXII	G	--	--	--	--	--	0.021937
Maylisu IV-Izbaskent, Vost. (E)	Jura. XXIII	G	--	--	--	--	--	0.021273
Namangan	Eoc. V	O	0.03	0.00	3062	21.11	1.452	--
Shorbulak	Eoc. V	O	0.03	0.00	3297	22.74	1.462	--
Tergachi	Mioc. kkp	O	0.03	0.00	1978	13.63	1.318	--
Tergachi	Eoc. V	O	0.04	0.00	3143	21.67	1.432	--
South Flank - NE of Fergana								
Alamyshik, Sever. (N)	Olig. II (III)	O	0.02	0.00	1735	11.96	1.271	--
Alamyshik, Yuzh. (S)	Plioc. I+Ia	O	0.00	0.04	749	5.16	1.143	--
Alamyshik, Yuzh. (S)	Plioc. Ib	O	0.00	0.10	643	4.43	1.121	--
Alamyshik, Yuzh. (S)	Mioc. Ic	O	0.00	0.10	615	4.24	1.116	--
Alamyshik, Yuzh. (S)	Olig. II (III)	O	0.00	0.10	421	2.91	1.079	--
Alamyshik, Yuzh. (S)	Eoc. V-VII	O	0.00	0.04	399	2.75	1.075	--
Alamyshik, Yuzh. (S)	L. Cret. XVIII	O	0.01	0.00	752	5.18	1.139	--
Alamyshik, Yuzh. (S)	L. Cret. XIX-XXII	O	0.01	0.00	826	5.69	1.146	--
Alamyshik, Yuzh. (S)	Jura. XXIII	GO	0.01	0.00	1076	7.42	1.195	--
Andizhan	Plioc. I	GO	0.00	0.00	914	6.30	1.123	--
Andizhan	Olig. III	GO	0.00	0.00	1940	13.38	1.254	--
Andizhan	Eoc. V	GO	0.00	0.00	2385	16.45	1.343	--
Andizhan	Eoc. VI	GO	0.00	0.00	2501	17.24	1.358	--
Andizhan	Eoc. VII	GO	0.00	0.00	2723	18.77	1.412	--
Andizhan	Paleoc. VIII	G	--	--	--	--	--	0.045450
Boston	Plioc. I	O	0.00	0.08	323	2.22	1.040	--
Boston	Mioc. Ia	O	0.00	0.08	601	4.15	1.094	--

Table F1. Miscellaneous Parameter Estimates, by Reservoir for Fields Discovered through 1987, Fergana Basin (English and Metric Units) Continued

Field Name	Pay Zone Identification	Petro-leum Type	Liquid Expansion Recovery Efficiency (frac)	Improved Oil Recovery Efficiency (waterflood) (frac)	Bubble-point Oil Reservoir Pressure (psi)	Bubble-point Oil Reservoir Pressure (MPa)	Oil FVF at Bubble-pt. Pressure (bbl/stb, cm/stcm)	Gas FVF at Abandonment Pressure (cf/scf, cm/scm)
Boston	Mioc. I	O	0.00	0.09	991	6.84	1.165	--
Boston	Olig. II (III)	O	0.00	0.09	769	5.30	1.095	--
Boston	Olig. III	O	0.00	0.09	1148	7.92	1.151	--
Boston	L. Cret. XIX	G	--	--	--	--	--	0.021200
Boston	L. Cret. XX+XXI+XXII	GO	0.01	0.00	2013	13.88	1.321	--
Boston	Jura. XXVII	G	--	--	--	--	--	0.020299
Boston	Permo-Trias. XXX	O	0.02	0.00	2570	17.72	1.421	--
Changyrtash	Olig. III	O	0.00	0.08	1567	10.80	1.192	--
Changyrtash	Eoc. V	O	0.00	0.03	1204	8.30	1.146	--
Chigirchik	Jura. XXIII	O	0.00	0.00	474	3.27	1.061	--
Khartum	Olig. III	O	0.02	0.00	1706	11.76	1.277	--
Khartum	Eoc. VI	O	0.01	0.00	2534	17.47	1.387	--
Khartum	Eoc. VII	G	--	--	--	--	--	0.018668
Khartum	L. Cret. XXII	GO	0.02	0.00	3419	23.57	1.544	--
Khartum, Vost. (E)	Olig. II-III	O	0.02	0.00	2039	14.06	1.293	--
Khartum. Vost. (E)	Eoc. VI	G	--	--	--	--	--	0.021748
Khodzhaosman	L. Cret. XVIII	O	0.00	0.00	1077	7.42	1.149	--
Palvantash	Plioc. I + Olig. III	O	0.00	0.00	138	0.95	1.021	--
Palvantash	Eoc. IV-VI	GO	0.00	0.00	175	1.21	1.030	--
Palvantash	Eoc. VII-VIII	GO	0.00	0.00	372	2.57	1.053	--
Palvantash	U. Cret. XIII+XIV	G	--	--	--	--	--	0.050682
Palvantash	L. Cret. XVIIIr	G	--	--	--	--	--	0.026373
Palvantash, Zap. (W)	Mioc. brp	O	0.00	0.00	449	3.09	1.088	--
Palvantash, Zap. (W)	Olig. IIIb	O	0.01	0.00	269	1.85	1.070	--
Palvantash, Zap. (W)	Eoc. V+VI	O	0.01	0.00	1601	11.04	1.215	--
Palvantash, Zap. (W)	Eoc. VII	O	0.01	0.00	1037	7.15	1.160	--
Palvantash, Zap. (W)	Eoc. VIII-IX	O	0.02	0.00	1550	10.69	1.221	--
Sharikhan-Khodzhiabad	Olig. II-III	O	0.00	0.08	1028	7.08	1.128	--
Sharikhan-Khodzhiabad	Eoc. V	O	0.00	0.00	935	6.45	1.131	--
Sharikhan-Khodzhiabad	Eoc. VI	G	--	--	--	--	--	0.066787
Sharikhan-Khodzhiabad	Eoc. VII	O	0.00	0.00	851	5.86	1.127	--
Sharikhan-Khodzhiabad	Eoc. VIII	GO	0.00	0.00	2261	15.59	1.277	--
Sharikhan-Khodzhiabad	L. Cret. XIX-XXII	GO	0.01	0.00	2205	15.20	1.337	--
Sharikhan-Khodzhiabad	Jura. XXIII-XXIX	GO	0.02	0.00	2191	15.11	1.349	--
Suzak	L. Cret. XIX	G	--	--	--	--	--	0.025675
Suzak	L. Cret. XXI	G	--	--	--	--	--	0.025199
South Flank - SW of Fergana								
Aksaray	Eoc. VII	G	--	--	--	--	--	0.060742
Aksaray	Paleoc. VIII	G	--	--	--	--	--	0.045473
Avval'	Eoc. V	O	0.00	0.00	890	6.13	1.123	--
Avval', Vost. (E)	Eoc. V	O	0.00	0.00	832	5.74	1.114	--
Ayritan	Olig. II (III)	GO	0.01	0.00	916	6.31	1.126	--
Ayritan	Eoc. V	O	0.01	0.00	1045	7.20	1.154	--
Ayritan	Eoc. VII	O	0.00	0.04	961	6.63	1.134	--
Ayritan	Paleoc. IX	G	--	--	--	--	--	0.029903
Beshkent-Togap	Olig. II (III)	O	0.01	0.08	576	3.97	1.075	--
Chaur-Yarkutan-Chimion	Eoc. IV	O	0.00	0.07	336	2.31	1.049	--
Chaur-Yarkutan-Chimion	Eoc. V, VI	O	0.00	0.08	475	3.27	1.053	--
Chongara-Gal'cha	Eoc. IV	GO	0.00	0.00	4568	31.50	1.501	--
Chongara-Gal'cha	Eoc. V	G	--	--	--	--	--	0.110742
Chongara-Gal'cha	Eoc. VII	G	--	--	--	--	--	0.100929
Karagachi-Tamchi	Eoc. IV	O	0.02	0.00	2649	18.26	1.338	--
Khankyz	Olig. II (III)	O	0.00	0.00	330	2.27	1.060	--
Khankyz	Eoc. VII	O	0.00	0.00	302	2.08	1.060	--
Khankyz	L. Cret. XVIII	G	--	--	--	--	--	0.020231
Kim (Sel'rokho)	Olig. II (III)	O	0.00	0.08	856	5.91	1.107	--
Kim (Sel'rokho)	Eoc. V	O	0.00	0.04	930	6.42	1.129	--
Kim (Sel'rokho)	Eoc. VI	O	0.00	0.09	963	6.64	1.133	--

Table F1. Miscellaneous Parameter Estimates, by Reservoir for Fields Discovered through 1987, Fergana Basin (English and Metric Units) Continued

Field Name	Pay Zone Identification	Petro-leum Type	Liquid Expansion Recovery Efficiency (frac)	Improved Oil Recovery Efficiency (waterflood) (frac)	Bubble-point Oil Reservoir Pressure (psi)	Bubble-point Oil Reservoir Pressure (MPa)	Oil FVF at Bubble-pt. Pressure (bbl/stb, cm/stcm)	Gas FVF at Abandonment Pressure (cf/scf, cm/scm)
Kim (Sel'rokho)	Eoc. VIa	O	0.00	0.09	964	6.65	1.134	--
Kim (Sel'rokho)	Eoc. VII	O	0.00	0.04	934	6.44	1.129	--
Nefteabad	Olig. II (III)	GO	0.00	0.00	903	6.23	1.121	--
Obi-Shifo	Olig. II-III	O	0.00	0.08	863	5.95	1.108	--
Rishtan, Sever. (N)	U. Cret. XIV	G	--	--	--	--	--	0.081116
Rishtan, Sever. (N)	U. Cret. XVI + XVII	O	0.00	0.09	1381	9.52	1.158	--
Rishtan, Sever. (N)	L. Cret. XVIIIr	G	--	--	--	--	--	0.049913
Rishtan, Sever. (N)	Jura. XXIII-XXIX	G	--	--	--	--	--	0.037655
Sarykamysh	U. Cret. XIV	G	--	--	--	--	--	0.149656
Sarykamysh	L. Cret. XVIIr	G	--	--	--	--	--	0.071018
Sarykamysh	Jura. XXIII	G	--	--	--	--	--	0.046832
Sarytok	Jura. XXVI	G	--	--	--	--	--	0.040843
Shorsu IV	Olig. II (III)	O	0.00	0.08	685	4.73	1.080	--
Shorsu IV	Eoc. IV	O	0.00	0.08	819	5.65	1.102	--
Shorsu IV	Eoc. V	OG	0.00	0.00	869	5.99	1.113	--
Shorsu IV	Eoc. VI	O	0.00	0.09	823	5.68	1.108	--
Shorsu IV	Eoc. VII	O	0.00	0.03	860	5.93	1.104	--
Shorsu IV	Paleoc. VIII	O	0.00	0.03	992	6.84	1.116	--
Shorsu IV	Paleoc. IX	O	0.00	0.08	1135	7.82	1.128	--
Shorsu VI	Eoc. VII	G	--	--	--	--	--	0.144823
Sokh, Sever. (N)	Olig. II	OG	0.01	0.00	1058	7.30	1.126	--
Sokh, Sever. (N)	Eoc. IV	GO	0.01	0.04	983	6.78	1.123	--
Sokh, Sever. (N)	Eoc. V	GC	--	--	--	--	--	0.033530
Sokh, Sever. (N)	Eoc. VII	G	--	--	--	--	--	0.033513
Sokh, Sever. (N)	Paleoc. VIII	O	0.01	0.04	993	6.84	1.143	--
Sokh, Sever. (N)	U. Cret. XIV-XV	GO	0.00	0.00	2190	15.10	1.269	--
Sokh, Sever. (N)	L. Cret. XVIIIr	GC	--	--	--	--	--	0.026576
Sokh, Sever. (N)	L. Cret. XXII	GC	--	--	--	--	--	0.025619
Sokh, Sever. (N)	Jura. XXIV-XXV	GC	--	--	--	--	--	0.021036
Tasravet	Eoc. IV	O	0.00	0.08	1056	7.28	1.154	--
Central Basin Graben								
Achisu	Olig. II (III)	O	0.02	0.00	1892	13.05	1.266	--
Gumkhana	Plioc. I	O	0.04	0.00	3816	26.31	1.537	--
Gumkhana	Mioc.(?)	O	0.05	0.00	4221	29.10	1.591	--
Kanibadam	Eoc. V	O	0.01	0.00	2219	15.30	1.255	--
Kanibadam	Eoc. VII	O	0.02	0.00	2059	14.20	1.253	--
Kanibadam	Paleoc. IX+IXa	GC	--	--	--	--	--	0.016648
Kanibadam, Sever. (N)	Olig. II (III)	O	0.02	0.00	1911	13.17	1.298	--
Madaniyat	Olig. II	O	0.03	0.00	2140	14.76	1.269	--
Madaniyat	Eoc. IV	O	0.02	0.00	2191	15.10	1.279	--
Madaniyat	Eoc. VII	O	0.03	0.00	2097	14.46	1.268	--
Makhram	Olig. II-III	O	0.02	0.00	2068	14.26	1.289	--
Mingbulak	Mioc. kkp	O	0.06	0.00	5823	40.15	1.705	--
Mingbulak	Olig. III	O	0.07	0.00	6077	41.90	1.850	--
Mingbulak	Paleoc. VIII	O	0.07	0.00	5146	35.48	1.883	--
Mingbulak	Paleoc. IX	GC	--	--	--	--	--	0.010750
Niyazbek-Karakchikum	Olig. II (III)	O	0.03	0.00	2528	17.43	1.314	--
Niyazbek-Karakchikum	Eoc. IV	O	0.02	0.00	2661	18.34	1.336	--
Niyazbek-Karakchikum	Eoc. V	O	0.03	0.00	2662	18.35	1.336	--
Niyazbek-Karakchikum	Eoc. VI	GC	--	--	--	--	--	0.013431
Niyazbek-Karakchikum	Eoc. VIIa	GC	--	--	--	--	--	0.013410
Niyazbek-Karakchikum	Paleoc. IX	GC	--	--	--	--	--	0.013353
Niyazbek-Karakchikum	U. Cret. XI-XII	GC	--	--	--	--	--	0.013379
Ravat	Olig. II (III)	O	0.00	0.00	4638	31.98	1.812	--
Ravat	Eoc. IV	O	0.02	0.00	934	6.44	1.142	--
Ravat	Eoc. V	GC	--	--	--	--	--	0.015156
Ravat	Eoc. VII	O	0.01	0.00	4042	27.87	1.385	--
Ravat	Paleoc. IX-IXa	GC	--	--	--	--	--	0.013207

Table F1. Miscellaneous Parameter Estimates, by Reservoir for Fields Discovered through 1987, Fergana Basin (English and Metric Units) Continued

Field Name	Pay Zone Identification	Petro-leum Type	Liquid Expansion Recovery Efficiency (frac)	Improved Oil Recovery Efficiency (waterflood) (frac)	Bubble-point Oil Reservoir Pressure (psi)	Bubble-point Oil Reservoir Pressure (MPa)	Oil FVF at Bubble-pt. Pressure (bbl/stb, cm/stcm)	Gas FVF at Abandonment Pressure (cf/scf, cm/scm)
Varyk	Olig. II (III)	O	0.02	0.00	1904	13.13	1.307	--
Varyk	Eoc. IV	O	0.02	0.00	3304	22.78	1.389	--
Varyk	Eoc. V	G	--	--	--	--	--	0.013357
Varyk	Eoc. VII	O	0.02	0.00	3071	21.18	1.380	--
Varyk	Paleoc. IX	O	0.02	0.00	3060	21.10	1.385	--
Varyk II	Olig. II (III)	O	0.04	0.00	2419	16.68	1.397	--
Varyk II	Eoc. IV	O	0.04	0.00	3082	21.25	1.426	--
Varyk II	Eoc. VII	O	0.04	0.00	3088	21.29	1.426	--
Total 53 fields and field-combinations	177 reservoirs	121 O-GO-OG 56 G-GC reservoirs						

Notes: At least 7 additional fields exist (1993 Uzbek & Petroconsultants information), which were probably discovered after 1987.

Volumetric calculations used piecemeal data sources and estimates. Some of the most sensitive data to calculations (reservoir area and thickness), were the least reliable. Bubble-point pressures for Gumkhana and Mingbulak fields are other examples of suspect estimates.

Listing of fields in the central basin graben is from Glumakov, et al, 1988; not all are deep-basin.

Initial field discovery year used for all reservoirs in that field.

For Mingbulak field, data listed with 1983* (asterisk) discovery year relate to estimates following the 1992 oil blowout.

Totals may not equal sum of components due to independent rounding. Other calculations also use complete values rather than the rounded values shown.

N-E-S-W as directions of north, east, south, and west.

? = particularly questionable.

Pay Zones as Plioc., Mioc., Olig., Eoc., Paleoc. are epochs of Tertiary Period (Pliocene, Miocene, Oligocene, Eocene, Paleocene). U. and L. Cret. are Upper and Lower Cretaceous Epochs. Jura. is Jurassic Period and Permo-Trias. is a composite zone of the Permian-Triassic Periods.

Pet. Type as petroleum in the reservoir; O = oil, G = natural gas, GC = gas condensate; when GO or OG is listed, the last letter indicates dominance in the pay.

Liquid expansion estimate for oil reservoirs above bubblepoint pressure (part of primary R.E.).

frac = decimal fraction.

Units as psi = pounds per square inch (assumed absolute); MPa = million pascals (assumed absolute); FVF = formation volume factor; bbl/stb = reservoir barrels per stock tank barrel oil, or cm/stcm as reservoir cubic meters per stock tank cubic meter oil. These "stock tank" units represent surface conditions.

Source: Energy Information Administration, Office of Oil and Gas.

Appendix G

Basic Unit Conversions Used

Appendix G

Basic Unit Conversions Used

Metric Unit	English Equivalent	
1 meter	3.280 839 895	*feet*
1 kilometer	0.621 371 192	*mile*
1 square kilometer	0.386 102 158	*square mile*
1 square kilometer	247.105 381 5	*acres*
1 hectare (10,000 square meters)	2.471 053 815	*acres*
1 cubic meter	35.314 666 72	*cubic feet*
1 cubic meter	6.289 810 570	*barrels* (42 U.S. gallons)
1 cubic meter	0.000 810 713	*acre-foot* [or, 1 acre-foot equals 1233.481 838 cubic meters]
1 hectare-meter	8.107 131 935	*acre-feet*
1 metric ton stock tank oil	7.392 929	*stock tank barrels* [overall Fergana basin; sum of reservoir-level stock tank barrels divided by sum of reservoir-level stock tank metric tons; ultimate recovery]
1 metric ton oil per cubic meter oil [or, specific gravity (s.g.) in grams per milliliter for liquids lighter than water]	[(141.5 / s.g.) - 131.5]	*degrees API gravity*
1 metric ton stock tank oil per barrel stock tank oil	[141.5 / (131.5 + API)] * 6.289 810 713	[used for sub-basin oil volumes with specific densities, not overall basin conversion]
1 cubic meter gas per metric ton oil [gas-oil ratio or "GOR"]	5.614 583 512	multiplied by oil density [in metric tons per cubic meter, or in s.g.] to obtain *cubic feet gas per barrel oil* [U.S. GOR]
1 degree Celsius [C] temperature	[(C * 1.8) + 32]	*degrees Fahrenheit*
1 million pascals pressure	145. 037 743 9	*pounds per square inch* (psi)
1 permeability unit [with 10 to the minus 15 square meters or 0.001 square micrometers]	1.013 249 966	*millidarcy*

Note: Fluid units shown in appendices and in diskette files are "stock tank" barrels, cubic meters, and metric tons of oil. No correction calculations for pressure or temperature bases were performed and thus the "stock tank" term serves to only identify oil volumes at general surface conditions, as opposed to reservoir conditions. The same is true for "standard" cubic feet or cubic meters of natural gas.